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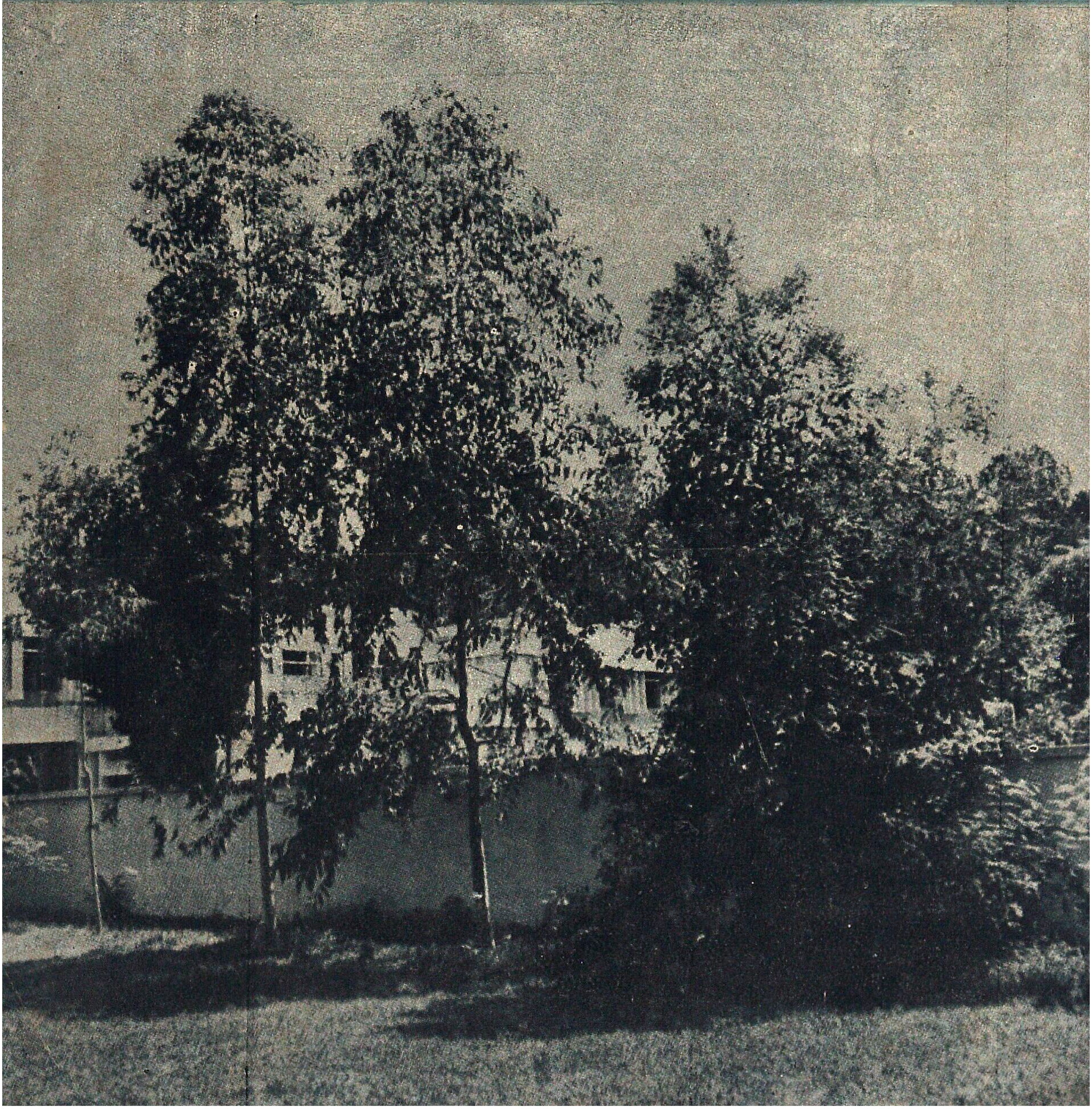

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(A Monthly Journal of Forestry and Forestry Research)

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VOLUME 110

NUMBER 6

THE
INDIAN FORESTER

JUNE, 1984

EDITORIAL

The cover photo of this issue shows two reciprocal F_1 hybrids of *Eucalyptus citriodora* × *E. torelliana* alongwith the parent species at age 2.5 years growing at New Forest, Dehra Dun. F_1 hybrids have displayed high degree of superiority over the parent species both in height and diameter, the two major components contributing towards higher biomass. Hybrids were also found resistant to fungus *Cylindrocladium quinqueseptatum*. The increase in crown and leaf size of F_{1s} over the female parent *E. citriodora* with its aroma has faciliated the scope for selection of desired re-combinants (i.e. from F_2 and subsequent generations). An article on this subject has already been published by Kapoor and Sharma in this Journal (Vol. 109, No. 12, 1983, pp : 891-900).

* * *

Spacing trials are an essential component long been conducted for various silvicultural research. Nelder suggested in 1962 a circular plot design for carrying out multiple spacing trials in a compact area at one site. The author on page 521 has come forward with a modification which is an improvement in the original Nelder pattern to obtain near rectangular and square spacings. We hope that this design will be useful for those engaged in forestry research in the field.

* * *

The article on page 529 presents important and interesting information on seed disposal system, germination and seedling establishment in natural forests of Silver Fir and Spruce. The study presents important phenological models essential for conducting regeneration studies in natural forests.

* * *

The authors on page 552 suggest various control measures to prevent and minimize the disease in nursery and in plantation areas caused by the charcoal root rot (*Macrophomina phaseolina*) in *Pinus caribaea* plantations in the Bastar region.

* * *

On page 577 the authors through their preliminary observations, under high magnification with the Scanning Electron Microscope installed in the Forest Research Institute, Dehra Dun, on the epidermal features of the leaves of *Eucalyptus* hybrid have shown that a lesser number of stomata per unit area appears to be an important characteristic of a 'cineole-rich' leaf. It is indicated that this observation could be used with advantage for screening of the plants for high cineole content using only light microscope in the field without the need of a distillation unit.

R.S. Mathur

Hony. Editor

A MODIFIED NELDER DESIGN TO ACHIEVE SQUARE OR TRIANGULAR SPACING

K.P. RUSTAGI
Associate Prof. University of Washington, Seattle (U.S.A.)

Nelder (1962) developed a circular plot design in which it is possible to put progressively increasing multiple spacing trials in one compact area. Figure 1 depicts a general configuration of the Nelder design. The data represent the plant location in concentric rings. As the plants are arranged along radiating spokes, the number of plants per ring is the same. This also causes the spacing on each outward successive ring to increase.

The relationship between number of spokes (n), chord distance (d) on the circular arc, and the arc radius (r), is given by $\text{Sin}\,(\pi/n) = .5d/r$

By specifying any two of the three unknowns, the value of the third can be computed. It is desirable to specify n in advance as otherwise its computed value may not be a whole number. Also d_o, the minimum chord spacing, is generally specified. Thus, r_o, the innermost arc radius is given by

$$(1)\ r_o = .5\, d_o/\text{Sin}\,\alpha$$

where $\alpha = \pi/n$: half the angle between two adjacent spokes.

Subsequent arcs in the Nelder design may be spaced in anymanner. If the objective is to compare spacing without changing the geometric proportionality, the chord distances, and arc radii should increase exponentially. If k is the multiplicative factor, then

$$d_{i+1} = k\, d_i \text{ and}$$

$$r_{i+1} = k\, r_i$$

with $k > 1$. The value of the k can be fixed arbitrarily. However, it can also be computed based on the desired properties of the trapizoid lattice.

For example (Figure 2) if it is desired that $e_{i,i+1} = .5\,(d_i + d_{i+1})$, then the computed value of k is given by (Appendix)

$$(2)\ k = (1 + \text{Sin}\,\alpha) / (1 - \text{Sin}\,\alpha)$$

Unfortunately, the plant configuration in Nelder design is neither square nor rectangular, the planting patterns commonly used. It is, however, possible to make trapezoids quite close to square or rectangular configuration by increasing the number of spokes. This will cause a large increase in arc radius for the same chord distance. For example, an increase in the number of spokes from 30 to 60 will increase the radius by 99.7% and the plot area by 299%. As the plants are located along spokes, triangular spacing cannot be tried in the conventional Nelder design.

If square or triangular spacing is desired, it is possible to achieve them without increasing the number of spokes, but by modifying the Nelder design. This is accomplished by locating additional plants at the intersection of two diagonals within each trapezoid. This will result in double the number of spokes and one more than the double of the number of arcs. Figures 3 and 4 show such a design. the dots give the location of main plants of the Nelder design, the crosses indicate the intersection of the two diagonals of the trapezoid formed by two adjacent main spokes and adjacent principal arcs. The cross marks also form a Nelder pattern with the additional property that perfect rhomboids are formed by the two plants along the principal arc and the two plants along the spokes on the auxilary arcs. In case of square spacing, the rhomboid becomes a square and the four closest crosses are equidistant from each dot. In case of the triangular spacing the closest four crosses and two dots are equidistant from each dot. In the modified Nelder design, the dots give the location of trees for measurement and the crosses give the location of additional trees to ensure equal spacing.

Table 1

The k values and radius multiplier for different number of spokes

Number of spokes	Computed k value using			Radius Multiplier
n	eqn (2) k	eqn (3) k_s	eqn (4) k_t	r
15	1.525	1.540	2.165	2.405
20	1.371	1.376	1.756	3.196
25	1.287	1.289	1.560	3.989
30	1.233	1.235	1.445	4.783
40	1.170	1.171	1.316	6.373
50	1.134	1.134	1.245	7.963
60	1.110	1.111	1.200	9.554

Table 2

Radii of principal and auxiliary arcs along with chord distances for square spacing
($n = 20$, $k_s = 1.376$)

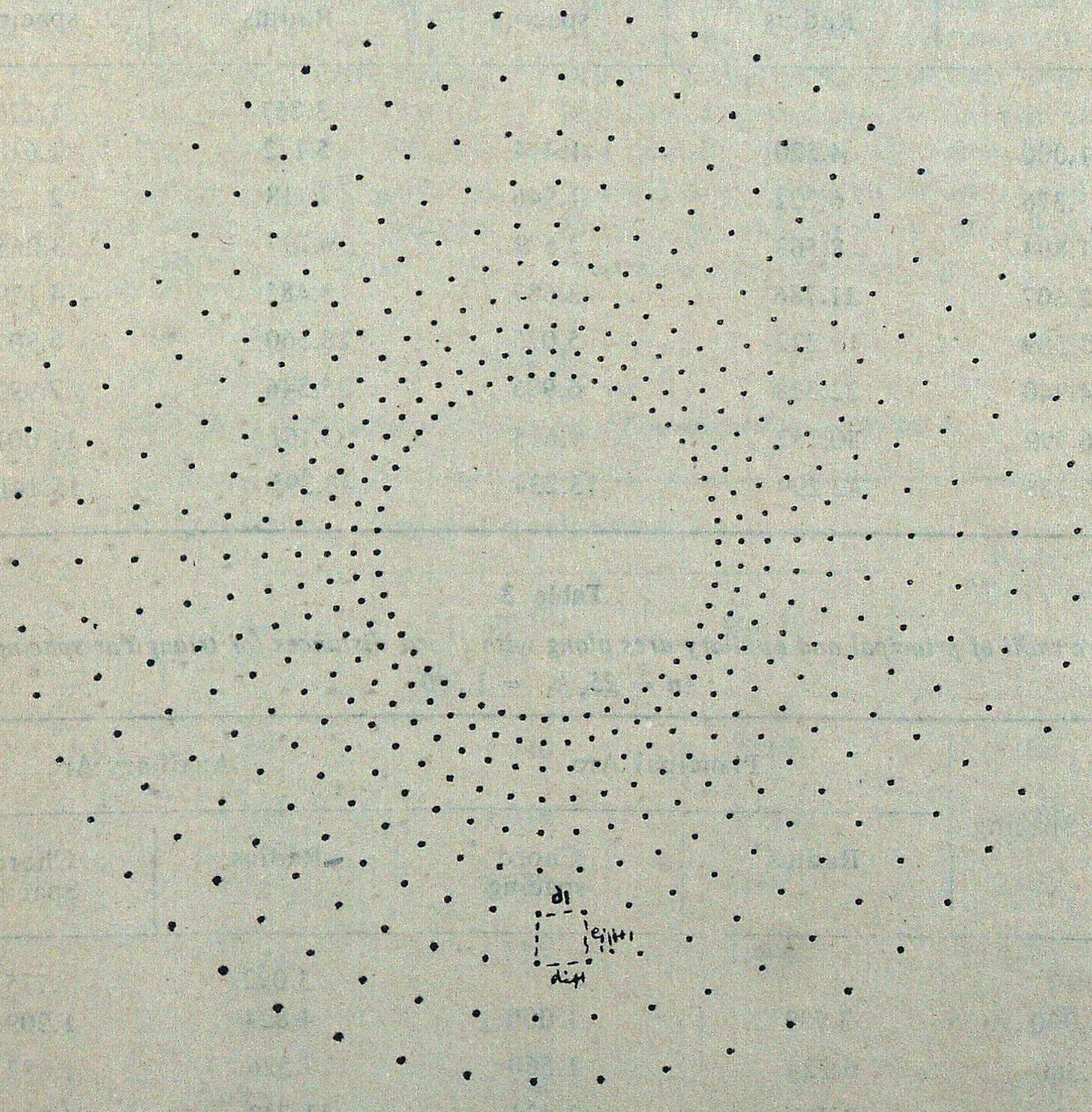
Plant Spacing	Principal Arc		Auxiliary Arc	
	Radius	Chord spacing	Radius	Chord spacing
			3.757	1.176
1.000	4.520	1.414	5.172	1.618
1.376	6.221	1.946	7.118	2.227
1.894	8.563	2.679	9.797	3.065
2.607	11.786	3.687	13.485	4.129
3.589	16.222	5.075	18.560	5.807
4.940	22.328	6.986	25.546	7.992
6.799	30.732	9.615	35.161	11.001
9.358	42 299	13.234	48.395	15.141

Table 3

Arc radii of principal and auxilary arcs along with chord distances for triangular spacing.
($n = 25$, $k_t = 1.560$)

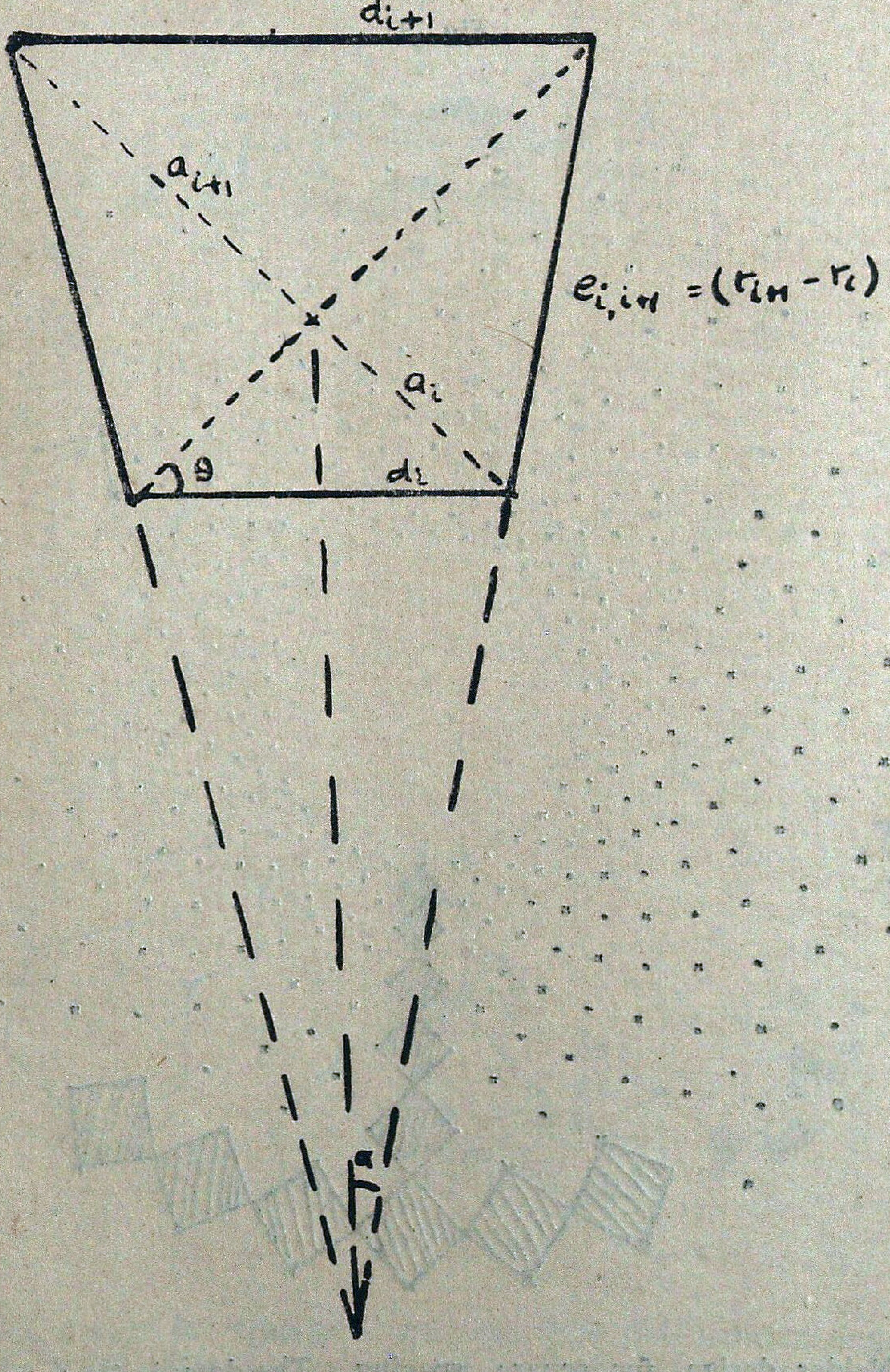
Plant Spacing	Principal Arc		Auxiliary Arc	
	Radius	Chord spacing	Radius	Chord Spacing
			3.092	.775
1.000	3.989	1.000	4.824	1.209
1.560	6.224	1.560	7.526	1.887
2.434	9.711	2.434	11.742	2.943
3.798	15.151	3.798	18.320	4.592
5.925	23.638	5.925	28.583	7.165
9.245	36.880	9.245	44.596	11.179

Fig. 1



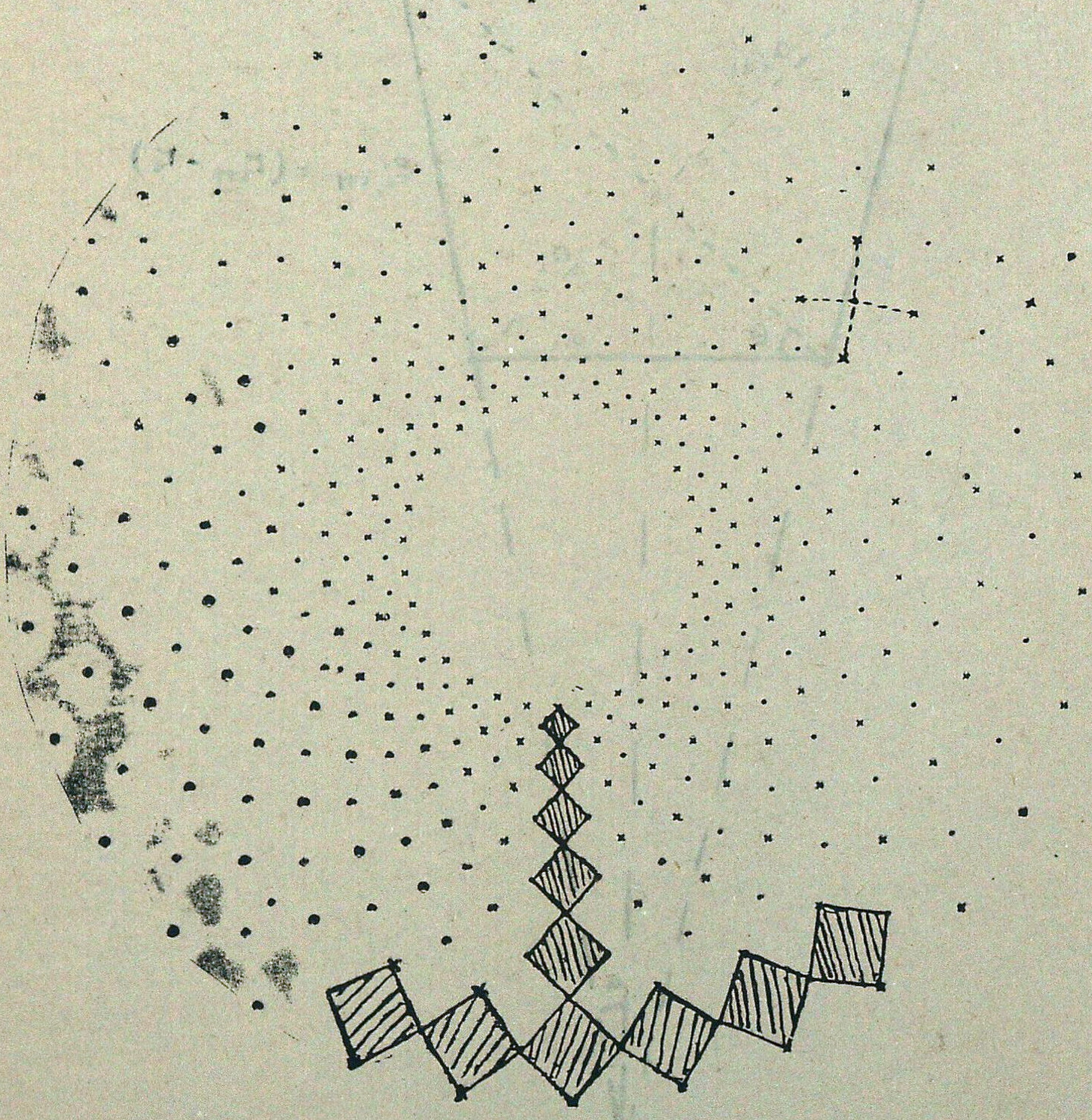
Nelder design with 50 spokes. Here $e_{i,\,i+1}$ is equal to the average of d_i and d_{i+1}

Fig. 2


d_{i+1}
a_{i+1}
$e_{i,i+1} = (r_{i+1} - r_i)$
a_i
θ
d_i
F

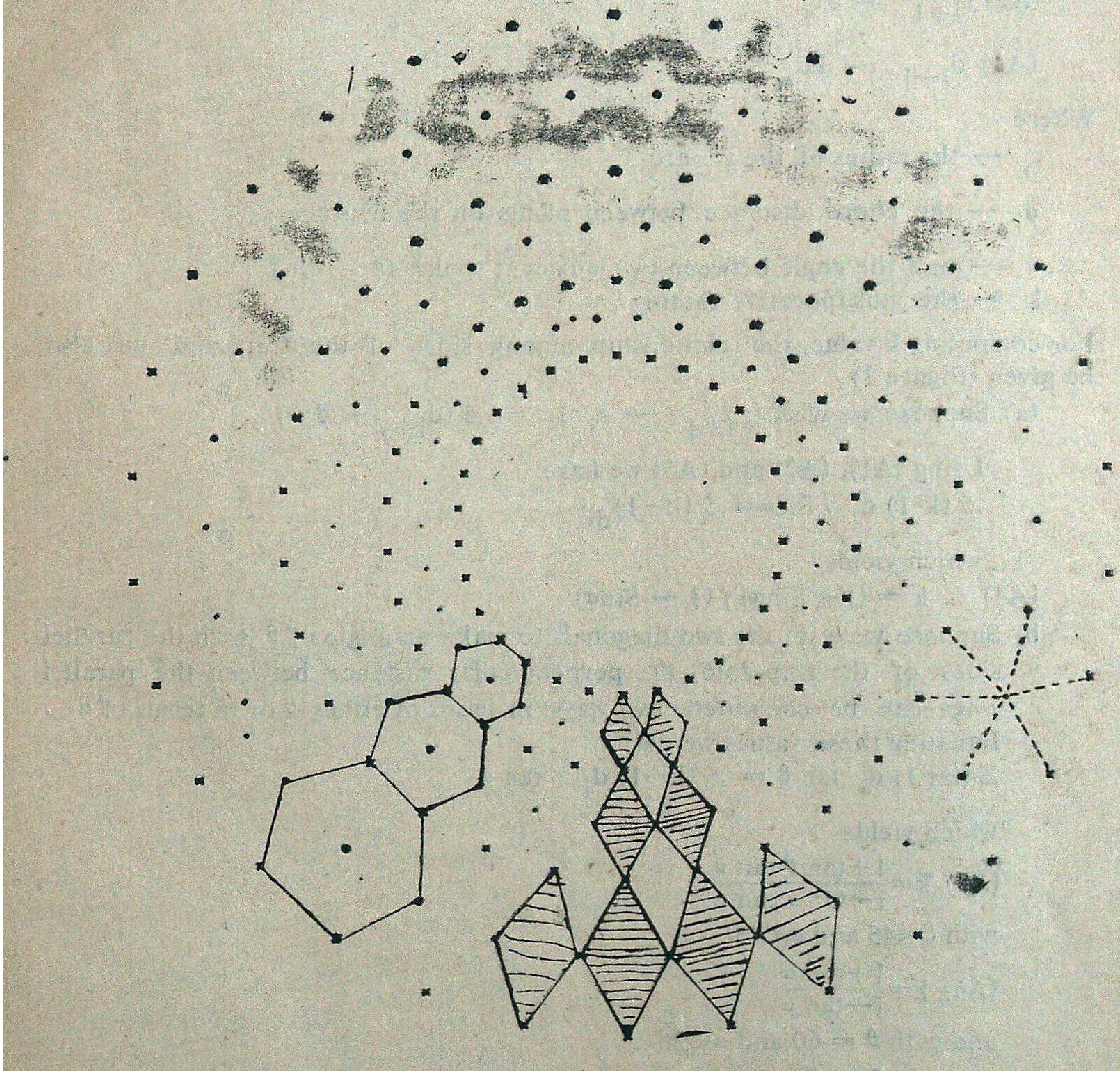
Geometric relationship between a_i, d_i, $e_{i,\,i+1}$ for specified θ and α.

Fig. 3



Modified Nelder design for square spacing. The dots indicate principal plant location and the Xs auxiliary plant location. Some of the formed squares have been shaded. Four equidistant plants from one primary plant have also been identified.

Fjg. 4



Modified Nelder design for triangular spacing. The dots indicate principal plant location and the Xs indicate auxiliary plant location. Some of the thomboids formed by two equilateral triangles have been shaded. Six equidistant closest plant to a primary plant have also bee n identified.

Appendix

Given

(A1) $r_i = .5\ d_i\ \text{Sin}\alpha$ $\quad i=0, 1, 2\ldots$

(A2) $r_{i+1} = kr_i$

(A3) $d_{i+1} = kd_i$

Where

r_i — the radius of the ith arc

d_i — the chord distance between plants on the ith arc

α — half the angle between two adjacent spokes ($\alpha = \pi/n$)

k — the multiplicative factor

For computing k value, the relationship among sides of the trapezoid must also be given (Figure 2)

(a) Suppose we wish $(r_{i+1} - r_i) = .5(d_{i+1} + d_i)$

Using (A1), (A2) and (A3) we have

$.5\ (k-1)\ d_i\ /\ \text{Sin}\alpha = .5\ (k+1)_{di}$

which yields

(A4) $k = (1+\text{Sin}\alpha)\ /\ (1-\text{Sin}\alpha)$

b) Suppose we want the two diagonals to make an angle of θ, with the parallel sides of the trapezoid, the perpendicular distance between the parallel lines can be computed two ways: in terms of either θ or in terms of α. Equating these values we get

$.5\ (k+1)\ d_i\ \tan\theta = .5\ (k-1)\ d_i\ /\ \tan\alpha$

which yields

(A5) $k = \dfrac{1+\tan\theta\tan\alpha}{1-\tan\theta\tan\alpha}$

with $\theta = 45$ and $\alpha < 45$

(A6) $k = \dfrac{1+\tan\alpha}{1-\tan\alpha}$

and with $\theta = 60$ and $\alpha < 30$

(A7) $k = \dfrac{2+\sqrt{3}\tan\alpha}{2-\sqrt{3}\tan\alpha}$

Reference

Nelder, J.A. (1962). New kind of systematic designs for spacing experiments. *Biometrics* 283-307.

SEED DISPERSAL, SEED GERMINATION AND SEEDLING ESTABLISHMENT IN NATURAL FORESTS OF SILVER FIR AND SPRUCE

I. SEED DISPERSAL PATTERN

VIRENDRA SINGH AND R.V. SINGH
Conifers Research Centre, Simla (Himachal Pradesh)

Introduction

Silver fir (*Abies pindrow*) and Spruce (*Picea smithiana*) are the two important coniferous species growing in western Himalayas where these two together constitute about half of the total coniferous growing stock. Seeding in these species is very erratic and one good seed year may be expected once in 3 to 5 years in case of spruce and silver fir respectively (Troup, 1921). The seed is dispersed in October-November. Seed dispersal pattern of silver fir and spruce has, however, not been investigated and the present investigation was accordingly undertaken.

Materials and Methods

This investigation was undertaken in Talghore forest of Kumarsain Range, Kotgarh Forest Division, Himachal Pradesh, which represented well the spruce and silver fir natural forests met with in Himachal Pradesh.

Eight experimental plots of 40 m × 40 m were laid out in this forest. The trees standing in each experimental plot were enumerated specieswise. Besides a mixed crop of spruce and silver fir, the experimental plots had scattered trees of blue pine (*Pinus wallichiana*), deodar (*Cedrus deodara*) and yew (*Taxus baccata*). Breast height diameter of each tree was measured by research callipers along and across the slope at right angles; mean of the two readings gave diameter at breast height of a particular tree.

In each experimental plot seed traps (wooden trays of 50 × 50 cm) were placed at a spacing of 5 × 5 m; the distance of the first seed trap from the boundary line was 2.5 m. Seed traps were made out of wooden planks. Plastic sheet of 150 gauge was nailed to provide bottom for each seed trap. The seed traps were placed in the experimental plots in the first week of October, 1981. Each experimental plot was fenced with four strands of barbed wire supported on wooden poles spaced 3 m apart.

The seed of silver fir and spruce was collected from each seed trap weekly beginning from 13th October. Weekly seed collection was continued till Ist December after which the area remained under snow till third week of April. Last seed collection was accordingly done on 24th April, 1982.

The seed collected weekly from each seed trap was separately bagged and brought to the laboratory for further studies which included seed count and determination of seed weight. On the basis of the number of seeds collected per seed trap (0.25 m^2) the number of seeds dispersed per square metre of forest floor area was calculated.

Results

Crop Composition. Diameter classwise number of trees of silver fir and spruce for different experimental plots are summarised in Table 1.

By number of trees, silver fir was more predominant than spruce except in experimental Plot 1. Silver fir trees were, however, mostly below 60 cm diameter while trees of 60cm and over in diameter in case of spruce formed fair proportion of spruce crop. Consequently, spruce accounted for more than 50 per cent of the basal area of the crop in all the plots except Plots 2 and 5; silver fir accounted for more than 50 per cent of the basal area of the crop in Plot 5 only (Table 2).

Seed Collection in Seed Traps. Table 3 summarizes the number of seeds collected per seed trap on different dates for all the plots.

The number of seeds collected per seed trap in the whole season in different plots is summarized in Table 4.

High values of standard deviation in Table 4 show that the number of seeds collected per seed trap in a plot varied widely and the seed was not uniformaly dispersed in a plot. The variability in the number of seeds collected in different seed traps was generally more in case of plots and species with a small quantity of seed dispersed.

Seed Dispersal in Different Weeks. Though the seed dispersal of both silver fir and spruce commenced almost simultaneously, the pace of seed dispersal in the former was faster than that in the later (Fig. 1). In case of silver fir the seed dispersal pattern in all the eight plots was broadly similar though the number of seeds dispersed varied widely from plot to plot. The seed dispersal curves exhibited three peaks i.e. in weeks ending on 20th October and 3rd and 17th November. Reduced seed dispersal in weeks ending 27th October and 10th November may be attributed to cloudy weather and rainfall during this period.

In case of spruce the trend of seed dispersal was, however, not similar to that in silver fir and the seed dispersal curves exhibited only two peaks in weeks ending 20th October and 17th November. The seed dispersal rate for both spruce and silver fir generally decreased after 17th November except in case of silver fir in plot 8.

The difference between plots in the number of seeds dispersed per square metre of forest floor area can be partly explained by the differences in basal area of silver fir and spruce in these plots. Figure 2 shows the number of seeds dispersed per square metre of forest floor area for each square metre of tree basal area in these plots. A comparison of Figures 1 and 2 shows that the differences between plots get very much narrowed in Figure 2. The relative position of plots in Figures 1 and 2 also changed. The

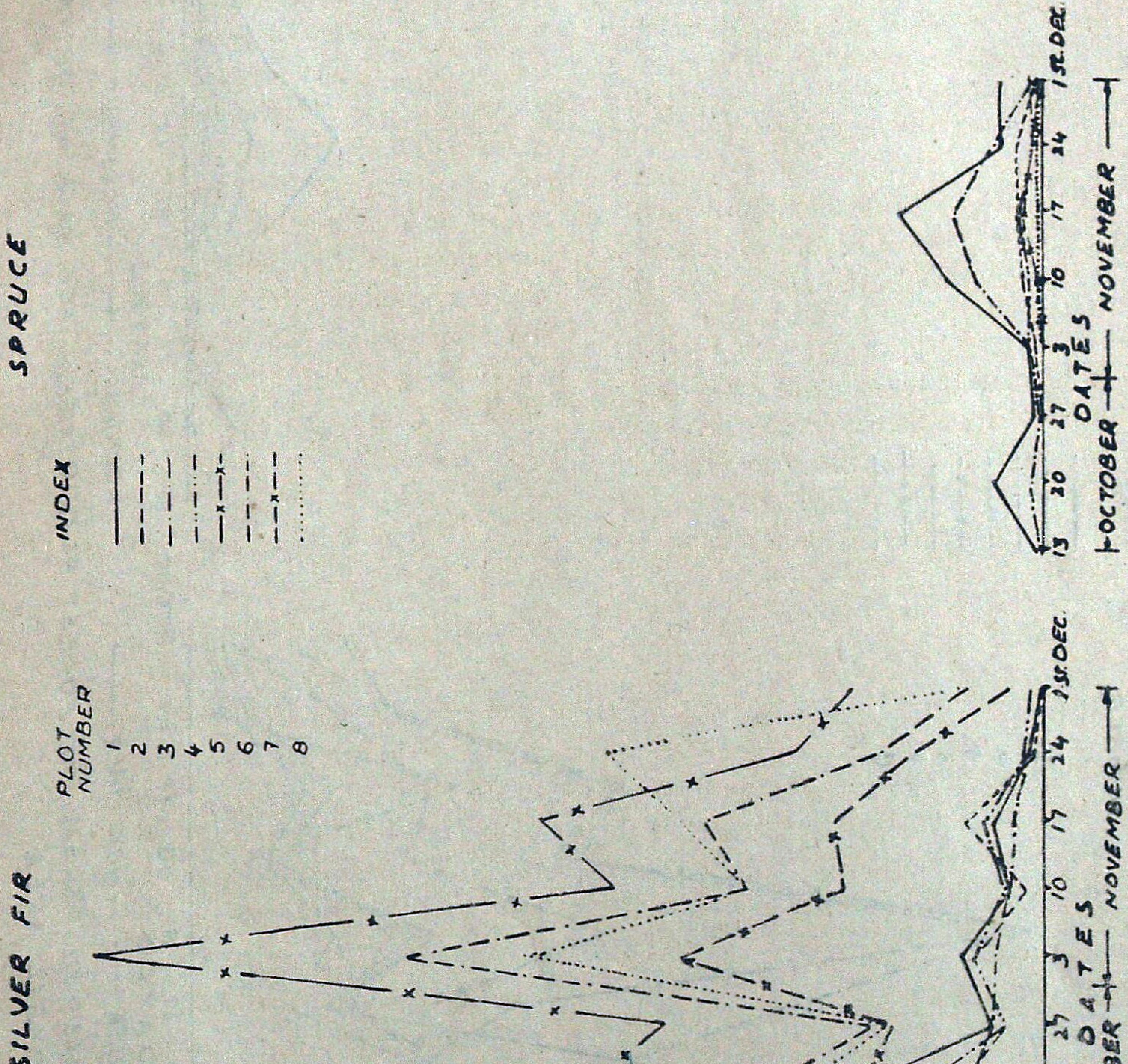


FIG. 1: SEED DISPERSAL / m^2 OF FOREST FLOOR AREA

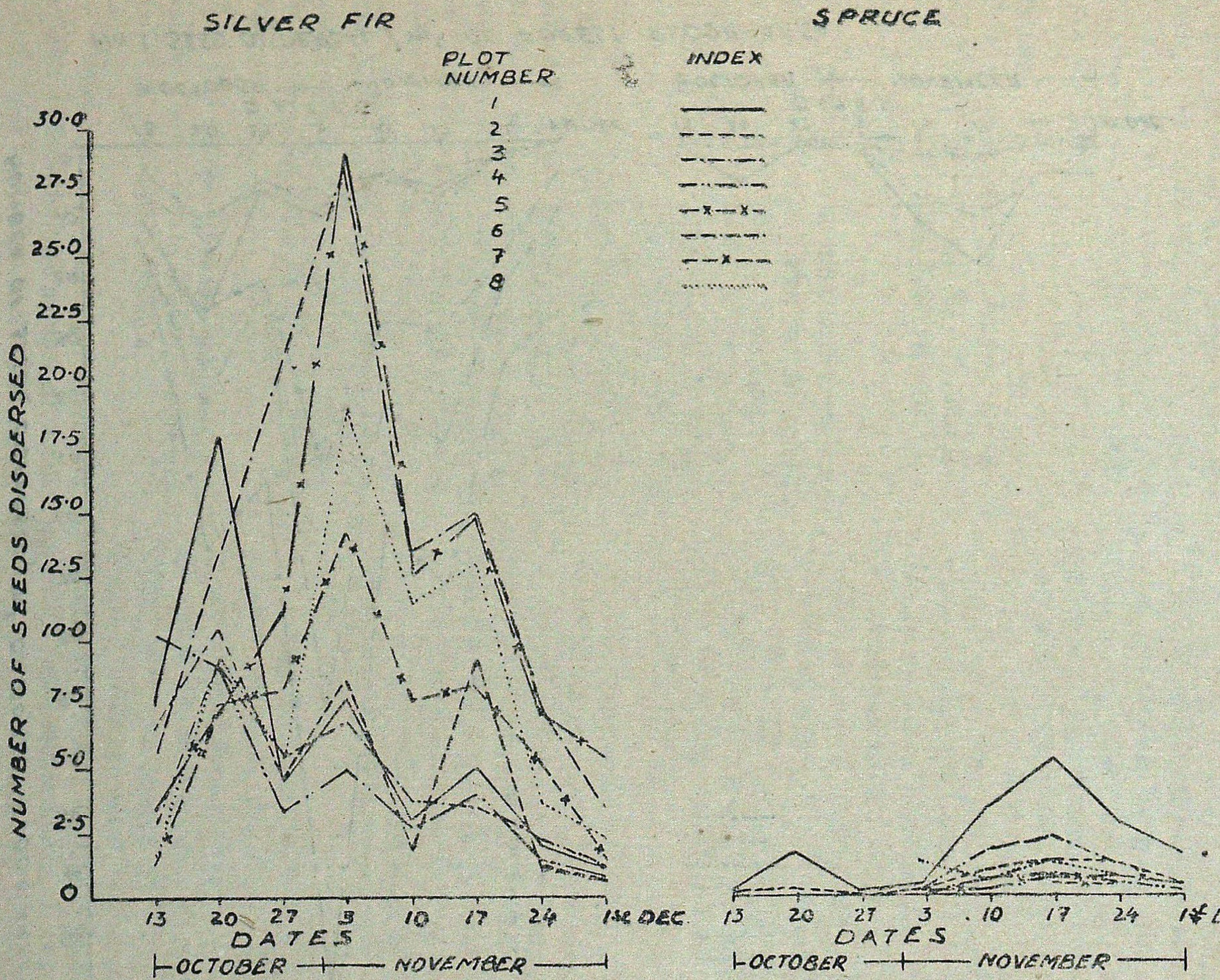


FIGURE 2: SEED DISPERSAL/m^2 FOREST FLOOR AREA FOR EACH m^2 OF TREE BASAL AREA

peaks in seed dispersal curves in both the figures were, however, broadly similarly placed.

Total Seed Dispersal. Table 5 summarizes number of seeds dispersed per square metre of forest floor area.

The number of seeds dispersed per square metre of forest floor area in case of silver fir and spruce varied from 51.9 to 528.6 and 9.2 to 65.8 respectively. Dobbs (1976) found that 130 seeds of white spruce dispersed in the middle of 200 m wide strip was 20 per cent of that recorded within the stand. Zasada, *et al.* (1978) reported total seed fall of 250 to 2000 seeds per square meter in undisturbed white spruce stands. The seed fall in a 75 year old red spruce stand was reported to be 5,480 seeds/m^2 (Powell, 1975). The variation in the number of seeds dispersed per square metre of forest floor area in different plots can be partly explained by the differences in the basal area of these species in these plots. Table 6 summarizes the number of seeds dispersed per square metre of forest floor area for each square metre of basal area of each of the two species in these plots.

Weight of Seed Dispersed. The weight of seed collected in all the traps in a plot on different dates of collection is given in Table 7.

The peak seed dispersal period for silver fir was after 13th October to 24th November during which period 85.84 per cent of the total seed collected during the season was dispersed. In case of spruce, however, seed dispersal during October (upto 27th) was very small when only 4.98 per cent of the total seed was dispersed. After 27th October to Ist December 84.50 per cent of the total spruce seed was dispersed.

Total weight of seed collected/m^2 of forest floor area in different plots is given in Table 8.

The weight of seed dispersed/m^2 of forest floor area varied from 1.62 to 19.15 g and from 0.13 to 0.78 g in case of silver fir and spruce respectively. Powell (1975) reported weight of red spruce seed dispersed/m^2 to be 1.46 g.

The variation in the weight per seed is shown in Table 9.

In case of silver fir, the seed dispersed after 13th October to 10th November was slightly heavier than that dispersed in other weeks; the seed dispersed after 10th November was generally lighter than the seed dispersed earlier. In case of spruce there was no clear trend discernible in this respect. This difference between silver fir and spruce can be explained by the difference in the method of seed dispersal in these species. The cones of silver fir disintegrate on the tree at the time of seed dispersal while those of spruce open out to disperse seed but do not disintegrate. In silver fir the seeds to be dispersed first are from the top portions of the cones and those to be dispersed last are from the bottom portions.

The fact that the seeds from the top and bottom portions of the cones are generally lighter than those from the middle portions of the cones explains the differences in seed weight collected on different dates in case of silver fir.

Table 1

Specieswise and diameter classwise number of trees in different plots

Diameter Class (cm)	Number of trees															
	Plot 1		Plot 2		Plot 3		Plot 4		Plot 5		Plot 6		Plot 7		Plot 8	
	sf	s	sf	s	sf	s	sf		sf	s	sf	s	sf	s	sf	s
0–10	—	—	6	—	2	—	1	—	1	—	—	—	2	—	—	—
10–20	14	5	12	2	14	1	31	4	40	—	16	6	25	—	32	—
20–30	14	7	6	3	12	2	17	3	20	—	12	3	19	2	23	5
30–40	4	18	3	8	3	3	6	6	22	4	14	4	21	5	18	—
40–50	2	8	2	6	3	6	—	8	6	2	3	3	3	6	5	3
50–60	—	2	1	2	—	13	—	3	—	1	—	9	1	5	—	3
60–70	—	—	—	1	—	4	1	4	1	4	1	1	—	4	—	4
70–80	—	—	—	1	—	1	—	3	—	3	—	5	—	1	—	4
80–90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Over 90	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Total	34	40	30	23	34	30	56	32	90	14	47	31	71	23	78	19

sf = silver fir, s = spruce

Table 2

Basal area of different species by plots

Plot Number	Basal area (cm²) of	
	Silver fir	Spruce
1	15820.77	40144.57
2	13188.05	32460.45
3	13781.74	59416.06
4	21662.90	58570.99
5	50198.71	34630.90
6	32832.61	54981.79
7	38198.03	44805.34
8	40342.65	44320.73

Table 3

Number of seeds collected per seed trap of 0.25 m²

Date of collection	Number of seeds collected per seed trap	
	Silver fir	Spruce
13.10.81	2.87	0.06
20.10.81	7.85	0.31
27.10.81	4.86	0.07
3.11.81	12.94	0.42
10.11.81	6.33	1.16
17.11.81	7.53	1.76
24.11.81	3.36	1.02
1.12.81	1.81	0.63
24.4.82	3.72	0.73

Table 4

Number of seeds collected per seed trap of 0.25 m^2

Plot Number	Number of seeds collected/seed trap	
	Silver fir	Spruce
1	20.83 ±13.89	16.45 ±10.44
2	14.11 ±14.71	3.73 ± 2.46
3	12.98 ± 9.15	9.78 ± 5.00
4	20.97 ±12.98	3.64 ± 2.11
5	132.16 ±42.55	2.48 ± 2.60
6	81.77 ±28.95	3.44 ± 2.94
7	53.36 ±32.28	2.31 ± 2.04
8	74.16 ±50.62	5.31 ±13.86

Table 5

Number of seeds dispersed per m^2 of forest floor area

Plot Number	Number of seeds dispersed/m^2 of forest floor area	
	Silver fir	Spruce
1	83.3	65.8
2	56.4	14.9
3	51.9	39.1
4	83.9	14.6
5	528.6	9.9
6	327.1	13.8
7	213.4	9.2
8	296.6	21.2

Table 6

Number of seeds dispersed per square meter of forest floor area for each square metre of basal area of trees

Plot Number	Number of seeds/m^2 of forest floor area and tree basal area	
	Silver fir	Spruce
1	50.48	17.22
2	45.35	4.93
3	37.38	6.85
4	40.21	2.50
5	40.21	2.96
6	104.11	2.60
7	99.59	2.16
8	55.54	4.07

Table 7

Mean weight of seed (mg) collected per seed trap

Date of collection	Mean weight of seed (mg) per seed trap*	
	Silver fir	Spruce
13.10.81	101.851 (5.30)	0.476 (0.68)
20.10.81	322.156 (16.78)	2.349 (3.35)
27.10.81	216.533 (11.28)	0.666 (0.95)
3.11.81	468.773 (24.41)	5.693 (8.13)
10.11.81	241.412 (12.57)	14.367 (20.51)
17.11.81	231.056 (12.03)	21.101 (30.12)
24.11.81	168.484 (8.77)	10.921 (15.58)
1.12.81	49.292 (2.58)	7.115 (10.16)
24.4.82	120.537 (6.28)	7.369 (10.52)

* Figures in brackets express percentage of total seed collection

Table 8

Weight of seed/m² forest floor area

Plot Number	Weight (g) of seed/m² forest floor area	
	Silver fir	Spruce
1	3.71	0.78
2	2.07	0.18
3	1.62	0.39
4	3.08	0.16
5	19.15	0.15
6	12.32	0.13
7	7.04	0.18
8	10.60	0.28
Mean	7.45	0.28

Table 9

Weight (mg)/seed for different collection/dates

Dates of collection	Silver fir	Spruce
13.10.81	35.570	8.413
20.10.81	41.030	7.613
27.10.81	44.590	10.029
3.11.81	36.189	9.800
10.11.81	38.149	12.383
17.11.81	30.687	11.991
24.11.81	32.710	10.900
1.12.81	27.313	11.420
24.4.82	31.439	10.088

SUMMARY

Studies on seed dispersal were carried out in a mixed forest of silver fir and spruce in Kotgarh Forest Division, Himachal Pradesh. The number of seeds dispersed per square metre of forest floor area in case of silver fir and spruce varied from 51.9 to 528.6 and 9.2 to 65.8 respectively. The peak dispersal period for silver fir was from 13th to 24th November when 85.84 per cent of the total seed (by weight) was dispersed while the same for spruce was from 27th October to Ist December during which period 84.50 per cent of the total seed (by weight) was dispersed. In case of silver fir the seed dispersed after 13th October to 10th November was slightly 5 heavier than that dispersed in other weeks and there was no such difference discernible in case of spruce.

रजत तालीशपत्र और प्रसरल के प्राकृतिक वनों में बीज विकिरण, अंकुरण और पौधों की स्थापना

I. बीज विकिरण का ढंग

लेखक वीरेन्द्र सिंह व आर०वी० सिह

सारांश

बीज विकिरण के ये अध्ययन हिमाचल प्रदेश के, कोटगढ वन मण्डल के रजत तालीशपत्र और प्रसरल के मिश्र वनों में किए गये। रजत तालीश पत्र और प्रसरल के वन भूक्षेत्रों में प्रति वर्गमीटर विकीर्ण हुए बीजों की संख्या क्रमशः 51.9 से 528.6 और 9.2 से 65.8 तक रही। रजत तालीशपत्र में बीज विकिरण की शिखर अवधि I3 से 24 नवम्बर तक रही जिसमें (भार के आधार पर) कुल बीजों का 85.84% भाग बिकीर्ण हुआ जबकि प्रसरल में यह अवधि 27 अक्तूबर से 1 दिसम्बर तक रही जिसमें (भार के आधार पर) कुल बीजों का 84.50% भाग विकीर्ण हुआ। रजत तालीशपत्र में 13 अक्तूबर से 10 नवम्बर के बाद विकीर्ण हुए बीज उन बीजों की तुलना में जो दूसरे सप्ताहों में विकीर्ण हुए थे, कुछ भारी थे जबकि प्रसरल के बीजों में कोई ऐसा अन्तर नहीं देखा गया।

References

Dobbs, R.C. (1976). White spruce seed dispersal in Central British Columbia. *For. Chron.* **52** (5) : 225–228.

Powell, G.R. (1975). Seed fall studies in red spruce. *For Chron.* **51** (2) : 55–58.

Troup, R.S. (1921). The silviculture of Indian Trees. Vol. III. Clarendon Press, Oxford.

Zasada, John. C., M.J. Foote, F.J. Deneke and R.H. Parkerson (1978). Case history of an excellent white spruce cone and seed crop in interior Alaska : cone and seed production, germination and seedling survival. Pacific North-West Forest and Range Experiment Station, ***USDA For. Serv. Gen. Tech. Rep.*** PNW-65, 63 p.

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AN ECO-BIOMETRICAL STUDY ON TIGER IN THE ESTUARINE ECO-SYSTEM OF SUNDARBANS

KALYAN CHAKRABARTI

Divisional Forest Officer,
Planning and Statistics (Statistics), Calcutta (West Bengal)

Introduction

Sundarbans is a unique marshy tract where venomous snakes, sharp-toothed sharks, lusty crocodiles, mysterious tigers and delicate spotted deer have given fantastic blending of fury and beauty. Sundarbans supports such a fascinating habitat wherein the working biological system is tough, resilient, adaptive and surely designed for survival but on the other hand it is intricate, complex, interrelated and interacting. It holds the brightest promise as the suitable area to inhabit the magnificient cat and also to support a compact biota for the perpetual maintenance of an integrated ecological fabric in nature.

The swamps of Sundarbans are a land of diverse eco-system. They are the biggest tracts of estuarine forests in the whole of the world covering about 10,000 square kilometres and one of the largest chunks of undisturbed forests and possibly form an ideal habitat for the tiger though an inhospititable one where tidal action promotes a rapid circulation of nutrients and salinity varies widely both in vertical and horizontal planes.

The vast expanse of swamps studded closely with a net work of tiny islands of mudflats supports a low wooded forest of high density of virgin beauty. The rivers around tiny mudflats form fantastic labyrinths, bifurcations where hard and pointed pneumatophores give a trying time to the lives of Sundarbans. Opposite, undirectional and oscillating tidal currents meet and exert considerable and complicated force for entire biota. Diurnal changes of salinity in water creates conditions to make physiological adjustments of the animal and plant communities very difficult. Sundarbans tiger project area is a negative estuary where the influx of fresh water is practically negligible. Tigers in general indicate euryhaline character as in many estuarins organisms.

The abundant pachydermatous fauna (Rhinoceros sondaicus Desmarest), swamp deer and wild buffaloes which were once pride of the Sundarbans no longer exist in the area. Yet it abounds with gigantic reptiles, voracious sharks, peculiar fish, sharp footed hog, delicate and fastidiously clean spotted deer and most cunning, tough, mysterious and mud hating tigers. It is a curious and anomalous tract with surface soil composed of black liquid mud, mud-skippers (chiefly called *Periopthalmus* and *Boleopthalmus*) climbing trees, tides running in two directions in the same creek, animals apathetic to water swimming across broad rivers. Deadly calm and tranquility prevail in one creek while in the next raging rivers, abundance of molluscs and crustaceans in one and not living creature in another; some creeks are deadly to approach, others easy; some are dry at low tide, others unusually deep. All these contrasts and contradictions have made the Sundarbans a tract of absorbing interest and subject of investigation and research.

An eco-biometrical study was attempted over a prolonged period of about fifteen years to bring out the interesting eco-biometrical relationship in the mystic terrain of Sundarbans. An attempt was also made to probe into the mystery of man-eating urge shrouding the tigers of Sundarbans. An attempt was also made to bring out the dynamics of the physical, chemical and mechanical environment of the fascinating terrain of Sundarbans.

Ecological investigation and findings

With regard to ecology of Sundarbans tiger and the behaviour pattern of the magical animal, the tiger had been studied by the author in great details. Some ecological relationships had been observed which clearly demonstrated the bio-ecological traits of Sundarbans tiger, which are briefly stated as follows :

(i) *Vast Operational Zone*

Human casualty is reported from all over the 15 blocks (65 compartments) covering 2585 km^2 of Sundarbans tiger project area. This observation records the presence of aggressive man-eaters all over the project area indicating also a high population of tigers.

Migration of tiger from block to block and across international boundary is a feature, as the animal has been sighted negotiating vast expanse of water. This may be for finding out elevated lands above inundation level and also to search for prey animals, especially human beings. On many occasions, such tigers exhibited immense tenacity to fight various types of odd situations and saved themselves in the face of inevitable destruction.

(ii) *High casualty of human being.*

Average annual human casualty had been reported to be 36, but unofficial reports record about 100 (the forest being contiguous to Bangladesh forests). Dead bodies could only be recovered from the man-eaters in about 28.5% cases. The balance 71.5% were lost to the man-eaters.

(iii) *Time of heavy human casualty*

Human casualty fluctuates from the lowest figures recorded during the rains to the highest during April and May. During these two months entire estuarine forests are flung into ceaseless activities owing to millions and millions of trees throwing new flush of leaves and flowers which attract myriads of swarms of *Apis dorsata* and honey combs are made all over the project areas. This coincides with the activities of all types of lives from Molluscs and Crustaces to *Homosupiens*. Cunning tigers seize this opportunity to kill large number of honey collectors besides fishermen, shell collectors, timber coupe workers, etc. in this season.

(iv) *Pattern of human casualty*

(a) *Time of operation of man-eaters.* The man-eaters have a diabolical, understanding of human nature as they kill men between 7 A.M. to 8 A.M. (morning), 3 P.M. to 5 P M. (afternoon) when the workers are just out to their work site and prepare to return to their camps in the evening (80% human casualty). Most notorious and cunning man-eaters are those that swim to the boat and mounts on it, choose their victim and jump into water with the dead body and back to the forests. This occurs at 11 P.M. mostly when the boatmen are fast asleep.

(b) *Age of the victims.* Middle aged men (between 35 to 45) are usual choice in their prey; they find them, perhaps, more daring and indifferent towards self protection. Such cases form about 80% of human casualty figures.

(v) *Salinity and Tiger*

Salinity of water is probably the most important factor responsible for a good percentage (25%) of tigers turning into man-eaters. Salinity and salt tolerance capability of tigers-their osmo regulatory mechanism, if any, adaptation to constant fluctuation of salinity level, effect of salt water of kidney, liver and entire physiological system are thought to be the factors responsible for aggressive behaviour in tigers.

Positive correlation has been established with high degree of salinity and maximum human casualty as mentioned in Table 1. Physiological and histological examination of kidney and liver of man-eaters will testify to the authenticity of the observation.

(vi) *Salinity and human casualty*

Forests have been classified according to forest types and also on the basis of inundation level. On both the cases several types of formations have been identified. Density of crop was determined and human casualty via-a-vis these forest types were plotted. "Pure Cereops" forest areas where water and soil salinity were found to be maximum also registered maximum human casualty.

The areas of "Pure Cereops" with only 5% of availability of tiger pugmarks account for 20% of human casualties while although Pure *Phoenix* stands highest in the matter of recording highest concentration of tiger pugmarks only rank fifth in matter of causing human casualties. The percentage of salinity is highest at Pure Cereops areas but it is also recording the maximum concentration of tiger. Tiger concentration and human casualties are least in Pure Oryza and *Rhizophora-Brugiera areas*. Although '*Heritiera-Excescaria-Cereops*' areas record only 3% of tiger population, but these areas contribute quite a significant percentage of human casualties (10%).

The figures for salinity percentage were obtained from analysis of soil samples collected from different habitat formation of Sundarbans Tiger Project area and in order to make the results comparative only the figures of salinity percentage which refer to those at 30 cm depth are only taken into consideration. These samples were collected during a

Table 1

Habitat formation type	Soil salinity percentage	Percentage frequency of tiger pugmarks	Frequency of tiger pugmarks	Frequency percentage of human casualties
1. Pure cereops	1.2%	5%	10	20%
2. Excaecoria-Cereops.	0.90%	15%	25	18%
3. Heritiera-Excaecoria-Cereops.	0.84%	3%	5	10%
4. Pure Phonenix	0.72%	20%	36	8%
5. Pure Excaecoria	0.68%	3%	5	8%
6. Avicennia-Oryza	0.60%	2%	4	2%
Avicennia-Sinnoratia	0.60%	2%	4	5%
Heritiera-Phoenix	0 60%	12%	22	10%
7. Beach Forests	0.50%	14%	25	2%
8. Heritiera-Exacaecoria	0.49%	2%	4	8%
Phoenix-Excaecoria	0.49%	18%	33	8%
Rhisophora-Brugiera	0.49%	2.5%	5	0.5%
9. Pure Oryza	0.44%	1.5%	3	0.5%
		100%	181	100%

period of about five years and properly analysed. Frequency percentage of tiger pugmarks and percentage of human casualties are the results of a sustained and intensive study. So it is apparent that the frequency of tiger pugmarks recorded in different Tiger Project areas are not localised either to high salinity or low salinity areas. No statistical correlation was also perceptible from the data of Table 1 that the human casualty is restricted to highly salinity areas only, although it could be seen that the habitat formations like Pure ***Cereops*** and ***Excoecaria-Cereops*** whose salinity percentage are more than others are also recording the maximum human casualties. However, a more detailed statistical analysis would be of interest to find out any definite relationship amongst the habitat formations, salinity percentage, human casualties and frequency percentage of tiger pugmarks.

(vii) *Tiger population*

Estimation of tiger population was made on the basis of (a) pugmark counting and analysis (b) actual sighting (c) number of human casualty in different blocks (d) date and hour of kill (e) intense interrogation of all permit holders in a particular day or month and on other information. The tiger population was estimated as 112 in 1972. In 1979 the tiger census which was conducted in Sundarbans tiger reserve under the control of the author recorded the tiger population as 205, and the present tiger population stands as 264.

(viii) *Prey animals*

Pigs and deer are primary prey animals and they are in abundance. The terrain, however, is a serious handicap for the tigers to prey on such animals; compelled by circumstances, therefore, they take to monkeys, fish, birds, crabs and even honey.

(ix) *Endogenous periodism*

Endogenous periodism is manifested by several estuarine organisms. The presence of a 'Biological Clock' on such organism has been suggested. The pattern of man-eating as manifested in fixed time of killing, maximum death at a block followed by a decline and then a rise succeeded by another at regular sequence, maximum casualty just before full moon and new moon clearly indicate some from of 'Endogenous periodism' in the estuarine tigers (Mechanism called Endogenous self sustaining oscillation-or in short E-S-S-O).

(x) *Behaviour pattern*

The behaviour pattern of tigers was classified as :

Category I

Inherent & designed man-eater (25%)	—Aggressive man-eater (80% of above 25%)
(Balance 75% non-man-eater)	—Lusty and adventurious man-eater (20% of above 25%)

Category II

Undesigned man-eater 15%.

Category III

Circumstancial man-eater 60%

Casualty and labour problem in Tiger Land.

Statistics reveal that 35,330 people go to the forest annually of which 4,580 are timber and firewood workers, 24,900 fishermen, 1,350 honey collectors and 4,500 from other professions. As such the problem of safety of all these worker is a striking one. Casualty of 800 persons in 20 years seems to be very high; even during the project period about 300 persons have been killed in nine years.

Poor villagers inhabiting the areas adjacent to the Reserved Forests have to survive and pursue their trade in shell, timber, firewood, fish and honey collection. Mare subsistence is of primary concern to them no matter how great are the risks involved. Many such ill fated traders die in the pursuit. Yet the survivors continue to work. They do not take any protective equipment for themselves.

The human safety should be of primary concern. The behaviour pattern so far unearthed gives the men good hints to be on safeside between 7 A.M. to 9 A.M., 3 P.M. to 4 P.M. and at 11 P.M. The people of age group from 35-45 should be on the guard. But hunger and lust know no law and therefore safety measures by men is of prime importance; simultaneously the man-eaters have to be identified and isolated. It is a great challenge. The author had been successful in reducing human casualties by strict adherence to these bio-ecological characteristics of the magical animal.

Biometrical investigation and findings

The Tigers of the Sundarbans are a "myth", yet their size can be ascertained.

There is no thumb rule to ascertain the size of a Sundarban tiger as in the case of measurement of height of an Indian elephant from the circumference or diameter impression of foot print of fore toe.

So far no methods exist for measuring length of tigers from their pugmarks. But such a method is absolutely necessary in the forests where tigers can hardly be sighted or killed or found dead.

Problem in Sundarbans : The forests are low and one of the densest anywhere in the world. In this dense low forests inundated twice daily by high tide and cut up by innumerable small and big channels and creeks, the cunningness of the tigers has reached a very high order. Their presence is felt, pugmarks seen; they kill human being in the forests, pick up victims from boat, yet they are hardly sighted. They cannot be easily killed over a bait as in the case of other tigers, cannot be trapped and therefore hardly can be measured to arrive at a definite conclusion about their size.

Measurement of pugmarks : Innumerable pugmarks were measured and according to size, these were divided into 5 (five) classes. Care was taken to eliminate any fallacy arising out of too much soft soil and on sand.

Many cases were, however, found in the forests where the pugmarks of fore and hind toes were available and measured subsequently. A few animals either killed or naturally dead were actually measured and a relationship could be mathematically established

By the use of normal equations, the constants a, b are celculated $\Sigma Y' = na + b\Sigma X'$

$$\Sigma X' Y' = a\Sigma x' + b\Sigma x'^2 \text{ where } n = 9,\ \Sigma = \text{summation}$$

$$\Sigma x' = 1415,\ \Sigma y' = 1099,\ \Sigma x'Y' = 18299,$$

$$\Sigma X'^2 = 259171,\ a = 78.10,\ b = 0.28$$

The regression equation comes to,

$$Y' = 78.10 + 0.28\,X' \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (1)$$

Table 2

Showing the data of Inter-distance Between Legs (Fore and Hind) and the Size of Pugmark

Sl. No.	Fore leg (cms)	Hind leg (cms)	Average of 2 & 3	Average of product of (2 × 3) X′ in cm²	Distance between fore and hind leg (cms) Y′	X′ × Y′	X′²	Y′²
1.	7.5×8.5	6.5×7.5	7×8	56	75	4200	3136	5625
2.	11×9	9×8	10×8.5	85	112	9520	7225	12544
3.	9.5×12.5	10.5×11	10×11.5	115	115	12225	13225	13225
4.	13×11	13×11	13×11	143	122	17446	20449	14884
5.	13.5×12.5	12.5×11.5	13×12	156	125	19599	24336	15625
6.	11.5×14	12.5×14	12×14	168	130	21840	28224	16900
7.	14×14.5	13×14.5	13.5×14.5	196	135	26460	38416	18225
8.	14×16	14×16	14×16	224	140	31360	50176	19600
9.	17×16	17×16	17×16	272	145	39440	73984	21025
			Total :	1415	1099	182090	259171	137653

between length/pugmark as follows :—

Tiger pugmark analysis of study

In order of find out the relationship between the size (length × width) of pugmark and the length of tiger representative areas in each of the forest compartments of Sundarbans were inspected and pugmarks of fore and hind legs and their distances were measured in centimetres using tiger tracer and by actual measurement. It was observed that with increase in the size of pugmark the inter-distance of fore and hind legs also increased.

Some figures on full length of tiger and the distance between the fore and hind legs were available from actual measurement. The entire data was analysed statistically and a suitable mathematical relationship between pugmark and the tiger length could be established from a suitable formula thus arrived at.

The figures shown in Tables 2 and 3 are the averages of about 400 pugmarks taken by means of tiger tracer and actual measurement. All these pugmarks have been statistically analysed and condensed into Tables 2 and 3. Scanty pugmark data on cubs reveal the paucity of cubs in the Sundarbans.

Let the relationship between the size of pugmark (product of length and breath) (X^1) and the distance between fore and hind legs (Y^1) be assumed to be of the following from :

$Y^1=a+bx'$ where a, b are constants to be determined in such a manner that the linear form gives the line of best fit.

Table 3

Showing the length of tiger and the interdistance between fore and hind leg

Serial No.	Interdistance between fore & hind leg (cm) (X)	Length of the tiger (cm) (Y)	XY	X^2	Y^2
1.	60	190	11400	3600	36100
2.	80	205	16400	6400	42025
3.	110	240	26400	12100	57600
4.	132	275	36300	17424	75625
	382	910	90500	39524	211350

Let Y = A + BX where
Y = length of tiger in centimetres
X = Interdistance between fore and hind legs.

In the same way, the constants A, B are calculated by means of normal equations :

$$\Sigma Y = 4A + B\Sigma X$$
$$\Sigma XY = A\Sigma X + B\Sigma X^2$$

The equations are :

$$910 = 4A + 382\,B$$
$$90500 = 382A + 39524\,B \quad \ldots \quad (2)$$

Solving (2) we get $A = 114.81$

$B = 1.18$, equation is

$$Y = 114.81 + 1.18\,X \quad \ldots \quad (3)$$

But $X = 78.10 + 0.28\,X'$ from (1)

Therefore, Regression equation correlating the length of tiger to the size of pugmark is given as follows :

$$Y = 206.97 + 0.33\,X' \quad \ldots \quad (4)$$

Where Y = length of tiger in centimetres.

X' = Size of pugmark (product of length and breadth) in cm^2. Thus if X' is known, Y can be determined with the help of the above equation.

The above equations (3), (4) have got some obvious drawbacks and should not be applicable for cubs which are equal to or less than 114.81 cms in length. But nevertheless, this equation is a rough guide to determine the length of tiger in Sundarbans. Since the length data for new born tiger cubs are difficult to record and in Sundarbans the percentage of tiger cubs is significantly less, the formulae can be safely used as a rough guide.

The co-efficient of correlation between size of pugmark and distance between fore and hind legs is computed and then t = test of significance is applied.

The co-efficient of correlation (r) was calculated to be 0.91.

Test of significance :

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$ Follows t-distribution with (n-2) degrees of freedom.

Therefore $$t = \frac{091 \times \sqrt{7}}{0.414} = 5.80$$

consulting t — table we find,

t. 05 with 7 d.f. = 1.895

t. 01 with 7 d.f. = 2.998

The observed t value is highly significant and thus there is reason to believe that a high degree of correlation exists between the size of pugmark and the distance between hind and fore legs.

In order to find out the coefficient of correlation between the inter-distance between fore and hind legs and the length of tiger, the coefficient of correlation is computed and then t′ test is applied.

The said coefficient of correlation between inter-distance between fore and hind legs and the length of tiger was calculated :

$$r = 0.99$$

To test, we apply

$$t = \frac{0.99 \times \sqrt{2}}{0.14} = 10.0 \text{ with 2 d.f.}$$

Table values :

t .05 with 2 d.f. = 2.920

t .01 with 2 d.f. = 6.965

Thus a high degree of correlation exists amongst the size of pugmark, inter-distance between fore and hind legs and the length of the tiger. In other words the linear regression equations found would serve as excellent formulae for predicting the length of the tiger from the observed data on the size of pugmark.

Conclusion

The forests have to be conserved—not for tiger alone but for acting as a natural barrier against severe cyclonic storm during the monsoon months. However, acute might be the public need, these estuarine forests have to be preserved to fight the mighty tidal wave of Bay of Bengal and to protect lives and properties of millions of villagers residing adjacent to the forests. The Project Tiger is essentially a Conservation Project for millions of poor men and it will directly or indirectly save entire floral and faunal population of the tract.

Let the forests live, and both the men and tiger co-exist for peaceful living.

SUMMARY

This eco-biometrical study on tigers in the unique estuarine eco-system of Sundarbans has enabled to throw light into the unknown biological properties of the marshy terrain of Sundarbans and established some unique ecological relationships between the man and the man-eater. A bio-metrical prediction formula derived from the study also brought out relationships between the length and pugmark of tiger which would be of immense value in wild life management and research. The revealing facts of ecology perceptible from this study has surely opened up new vistas of thought and research into the wild life ecology of tiger and of the unique habitat of Sundarbans which is a proverbial name in the world with tigers on land and crocodiles on water.

Estuarine tigers of Sundarbans are popularly called inherent man-eaters having high degree of cunningness. They took heavy toll of precious human lives (over about 300 in undivided Sundarbans a year). A Study ranging over a period of about fifteen years by the author since 1968 covering salinity of soil, water, flora, fauna, predator-prey relationship enabled him to classify tigers according to their behavious pattern (aggressive, circumstancial, etc.) and other biological aspects of the animal. Casualty pattern among various professional forest workers were determined along with pattern in the method of kill, exact time of kill, choice of victim, their age etc. The pattern of activities of the animal was found to be somewhat 'Thythmic', reminiscent of "endogenous self sustaining oscillation" that some estuarine organisms have. It was found that closure of the 'Core area' of project tiger to the permit holders provoked the animal to migrate to adjacent blocks in search of human food. Pugmarks were classified into five classes and a regression equation correlating the size of pugmarks with length of tiger was established. Salinity determination of water and soil by use of Spearman's rank correlation coefficient formula revealed remarkable closeness between human casualty and high degree of salinity.

It was felt that the present study was extremely complicated in the diverse habitat and called for concerted research of scientists from various sphere of forestry and biology.

सुन्दर वन की नदीमुख परिस्थिति प्रणाली में बाघ का परिस्थिति जैवमात्रिकी अध्ययन

लेखक कल्याण चक्रवर्ती

सारांश

सुन्दर वन की विलक्षण नदीमुख परिस्थिति प्रणाली में बाघों के इस परिस्थिति जैवमात्रिकी अध्ययन से सुन्दर वन की दलदली भूमि की कुछ अज्ञात जैविकीय विशिष्टताओं पर प्रकाश पड़ा है और उससे मानव और मानव-भक्षी में कुछ विलक्षण पारिस्थिकीय सम्बन्ध स्थापित किये जा सके हैं। इस अध्ययन से निष्पन्न किए गये जैवमात्रिकी भविष्यकथन सूत्र ने बाघ की लम्बाई और उसके पगचिह्नों में भी कुछ सम्बन्ध स्थापित किये हैं जो वन्य प्राणी प्रबन्ध और अनुसंधान कार्यों के लिये बहुत अधिक मूल्यवान रहेंगे। इस अध्ययन से प्रकट होने वाले पारिस्थिकी पर्यालोकन तथ्यों ने तथा सुन्दर वन के विलक्षण प्राकृतावास के विषय में निस्संदेह नए क्षेत्र खोल दिये हैं जो भूमि पर बाध और जल में घड़ियाल के लिए विश्व भर में प्रसिद्ध क्षेत्र माना जाता है।

सुन्दर वन के नदीमुख प्रदेश में मिलने वाले बाघ जन्मजात नरभक्षी के रूप में कुख्यात हैं और वे बहुत अधिक चालाक होते हैं। वे काफी अधिक जन संहार करते हैं। (अविभाजित सुन्दरवन में प्रतिवर्ष लगभग 300 ये भी अधिक)। सन् 1968 से आरम्भ करके प्रस्तुत लेखक ने पन्द्रह वर्ष तक यह अध्ययन जारी रखा जिसमें मृदा की लवणता, जलीय पेड़-पौंधे, पशु-पक्षी हिंस्रता-हिंसित सम्बन्ध लिए हुए थे, जिनके आधार पर बाघों को उनके व्यवहार के रूप (आक्रामक, परिस्थितिजन्य आदि) तथा इस पशु के अन्य जैविकीय पक्षों के अनुसार वर्गीकृत किया जा सका है। विभिन्न पेशेवर वन कामगारों की मृत्यु के ढंगों को विनिश्चित किया गया तथा मारने की रीति, मारने का ठीक-ठीक समय, हता का चुनाव, उनकी उम्र आदि भी लिखे गये हैं। इस पशु के कार्य-कलाप का ढंग कुछ-कुछ "लयपूर्ण" जैसा पाया गया जो कतिपय नदीमुख जीवों में मिलने वाले "अर्न्तजात स्वयं-पोषी दोलन" का स्मरण कराता है। देखने में यह आया कि बाघ परियोजना के भीतरी क्षेत्र को अनुज्ञप्ति धारियों के लिए बंद करने पर यह पशु मानव आहार की तलास में आसपास के क्षेत्रों में प्रव्रजित होने को प्रेरित हुआ। इसके पगचिह्नों को पांच वर्गों में बाँटा गया और प्रतिपायन समीकरण द्वारा पगचिह्नों के आकार का बाघ की लम्बाई से सहसम्बन्ध स्थापित किया मया। स्पीयरमैन रैंक सहसम्बन्ध गुणांक सूत्र द्वारा जल और मृदा की लवणता विनिश्चित करने से मानव के मारे जाने और अत्यधिक लवणता में उल्लेखनीय निकटता सम्बन्ध पाया गया।

यह महसूस किया गया कि नाना प्रकार के इस प्राकृतावास में यह अध्ययन करना बहुत अधिक जटिल कार्य है और इसे भली-भांति सम्पन्न करने के लिए वानिकी और जैविकी के विभिन्न क्षेत्रों के वैज्ञानिकों द्वारा मिलकर अनुसंधान करने की जरूरत है।

References

Chakrabarti, Kalyan (1978). Ecology of the Sundarbans tiger with particular reference to Range of habitats and adaptibility to changes. *Cheetal*, 20 (2) & (3) 3-15, Dec. 1978/March 1979.

Chakrabarti, Kalyan and A B. Chaudhury (1972). Wild Life Biology of the Sundarbans Forests—observations on Tigers Vol. XV, June, No. I (IUCN Special issue), 11-31.

... ... (1974). Human casualties from man-eating tigers can be reduced, published in Vol, 40, May, *Science and Culture*, 207-210.

... ... (1973). Wild life Biology of the Sundarbans Forests—A study of the habit and habitat of the tigers, published in *Bulletin of Botanical Society of Bengal*, 26 (1), 63-66.

AN OBSERVATION ON THE INCIDENCE OF CHARCOAL ROOT-ROT DISEASE OF *PINUS CARIBAEA* PLANTATIONS OF BASTAR (M.P.)

JAMALUDDIN, V.S. DADWAL AND K.K. SONI
Regional Forest Research Centre, Jabalpur (Madhya Pradesh)

Introduction

Charcoal root-rot (caused by *Macrophomina phaseolina*) was reported to be one of the most important disease in forest nurseries particularly in pine plants (Seymour and Cordel, 1979). It was reported first time from India by Jamaluddin *et al.* (1982). The disease has now been found to cause considerable damage in 1470 hectares plantation of *Pinus caribaea* in Bastar (M.P.). The extent of damage was so alarming that the forest department had to give up further plantations of *Pinus carbaea* in Bastar. An extensive survey in 1981 and 1982 was undertaken to assess the disease intensity and its characteristics so as to recommend control measures in the current plantations and to suggest the preventive measures for future plantation programmes.

Observation

The mode of infection caused by M. phaseolina.

It is very difficult to detect the infection caused by *M. phaseolina* at the initial stages of disease. The fine rootlets are the ideal places of infection by this pathogen. Occassional root injury also facilitates the infection. The fine roots are first attacked by this fungus. As the attack of pathogen progresses, supply of nutrients and water appear to be affected due to blocking and disintegration of tissues as is evident from the actions of diseased portions. The active mycorrhizae could not be detected in the senescent seedlings.

Disease situation.

The disease was assessed by laying random sample plots in different compartments of Kurandi, Bhanpuri and Jamgaon plantations. The sample plots were laid out in different areas so as to represent the entire land surface of the plantations. In each of the substratum three sample plots, with 100 plants in each plot were laid out in each compartment. The disease infestation was assessed on existing healthy, senescent and diseased plants. The data on the observations of disease infestation has been presented in Table 1.

Conditions favourable to the development of Disease.

The development of the disease appeared mainly during the period of moisture stress. It has been observed that the disease infestation is more pronounced in hilly areas than on flat surface. The possible reason for the effect of slopes on disease infestation may probably be due to excessive water run-off and consequent moisture stress in hilly areas.

In Bhanpuri area major portion of 32 hectare 1977 plantation of *Pinus caribaea* suffers due to water logging, due to which *M. phaseolina* attack was found to be more rampant. Physiologically, the water logging also creates conditions of moisture stress and thus facilitates the attack of pathogen.

In Jamgaon flat-slaty rocks are present below 15 cm soil depth. The seedlings planted in this area are thus faced with moisture stress when the roots strike this hard layer. During summer months when plants are subjected to excessive moisture stress, attack of *M. phaseolina* becomes more pronounced.

Spread of the Disease.

Agricultural and wild leguminous plants are the most suited collateral hosts for this fungus. It has been observed that *Cassia tora*, *Cassia auriculiformis* and *Cassia pinnata* were growing as weed, where the soil mix was being prepared and the seedling stock was maintained for plantations. In some places where intercropping of leguminous crops like Moong *(Vigna aureus)* and Urid *(Vigna mungo)* was tried with *P. caribaea*, the infected roots of these pulses produced sufficient inoculum of this pathogen for spread of infection in *P. caribaea* plantations.

The soil samples from nursery-beds showed positive evidence of this fungus. The fungus was also present in the soil samples of the natural forest and in the roots of wild leguminous plants growing on the plantation sites. The conditions which favour the spread of disease infection are the use of unsterilised soil in the potted mixture and nursery seedlings raised by frequent watering and fertlizer applications. When such plants are planted in the field they are not able to adjust to the conditions of moisture stress. As a practice before actual planting in fields, the root portions of the nursery seedlings containing mycorrhizal infections are also trimmed. Thus the roots are made more susceptible to pathogen attack, firstly due to injured root system and secondly on account of trimming of sizeable root portions containing mycorrhizal growth. Collateral host leguminous plants grown as intercropping also aggravated the disease infestation. Replacement of diseased seedling by planting of healthy plants in the same pit was found to meet the same fate because the pathogen which caused the death of first plant was still there. Presence of inoculum in the pit was found to be sufficient in infecting the newly transplanted seedlings. Another peculiar situation existing in this area is tall and dense grass growth which comes up gregeriously after clear felling of original moist type of sal and other tree vegetation. This dense grass growth appears to drain out moisture and nutrient. The consequent moisture stress and nutrient deficiency thus aggravate the attack of this pathogen.

Control measures

The intensity of the inoculum can be reduced by modifying the nursery management practices. The mycorrhizal infected soil from old plantation of *P. caribaea* plantations should be avoided because they may contain inoculum of this pathogen.

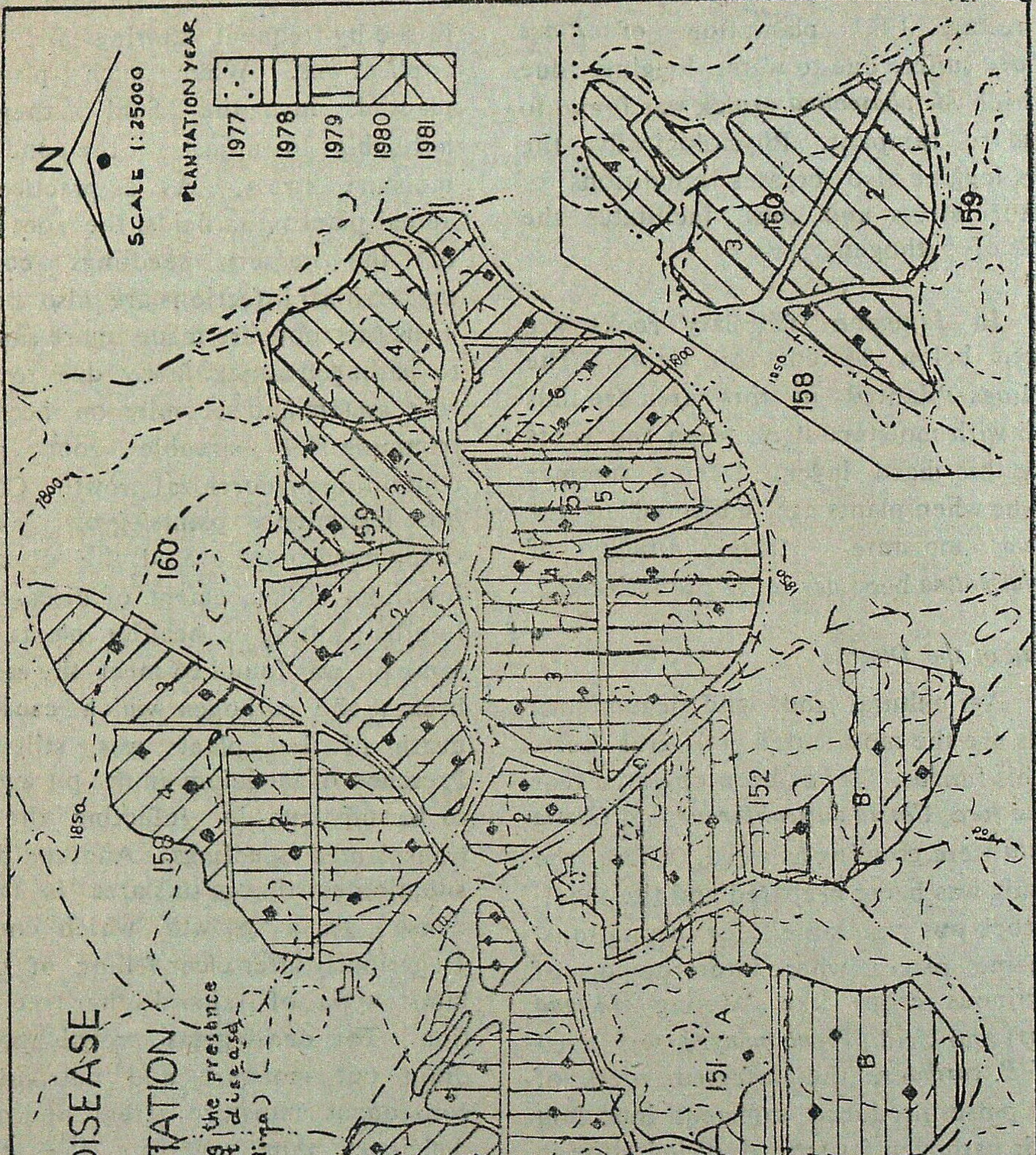
EVIDENCE OF DISEASE
IN
PINE PLANTATION
◆ Sample plot showing the presence of charcoal root rot disease (M. Phaseolina)
N
SCALE 1:25000
PLANTATION YEAR
1977
1978
1979
1980
1981
158
159
160
153
152
151
154
A
B
1800
1850

Table 1

The percentage of disease in different compartment of Pine plantation

Compt/ Section	Year of plantation	Disease percentage			
		Flat area	Slope area	Hill top area	Average disease percentage
151/A	77	40	31	55	42
151/B	78/80	45	42	32	39
152/A	78	63	71	62	65
152/B	78 to 81	36	34	50	40
153/1	79, 80	21	90	17	43
153/2	79	31	34	73	46
153/3	79	36	53	83	57
153/4	79	38	49	98	62
153/5	79	33	75	84	58
153/6	80, 81	82	59	75	72
153/7	79, 80	54	96	100	83
157	81	73	32	—	53
158/1	79	78	79	93	83
158/2	79	72	63	86	73
158/3	80	68	84	22	58
158/4	80	38	28	18	28
159/1	80	87	11	62	53
159/2	80	44	45	31	40
159/3	81	62	63	78	68
160/1*	81	86	62	62	70
Bhanpuri*	77	96	24	46	55
Jamgaon	80	65	24	92	63

*All the three sample plot belongs to the flat land facit.

Leguminous weeds such as *Cassia tora*, *Cassia auriculiformis*, *Cassia pinnata* etc. which are growing in wild stage should be weeded out if found in the vicinity of *P. caribaea* plants, in field and in nursery. Similarly intercropping with leguminous plants should be avoided as they are equally susceptible to this infection.

Soil mix or potted mixture should be thoroughly sterilized before filling in the polythene bags with the help of formaldehyde solution (250 ml of solution may be diluted to 4 litres of water). About 1 to 1.5 litres of this solution may be sprayed on the top 15 cm soil of the seed bed (1 m × 1 m) in nursery. Alternatively, the above fumigant should be thoroughly mixed with the soil mix and covered with polythene sheets. The fumigation should be done before 10 to 15 days of seed sowing The fumigated soil mix should also be exposed to open sun.

Addition of fertilizers should be avoided during nursery stage because *P. caribaea* does not require much fertilizers during early stages. The nutrient requirements of the plants is likely to be made good by the presence of mycorrhiza in the plants.

The replacement of casualities should not be done in the pit in which the seedlings were already affected by fungus because there are chances for infection to newly planted seedling also. The fresh pit may be prepared.

Care must be taken to avoid any root injury to the nursery seedlings. The soil drenching with 0.05 per cent bavistin or 0.1 per cent brassical during April to June considerably reduce the disease because the pathogen is active during this period. Thorough weeding of grasses during July to September is very essential to prevent competition of grasses with plants for nutrients and moisture.

Acknowledgement

The authors are thankful to Dr. Ram Prasad, IFS, Officer-in-Charge, for every kindly going through the manuscript and for making useful improvement in the paper. Thanks are also due to Shri V.S. Chauhan, Manager Site Assessment Unit and Shri M.L. Kharche, Research Officer (Pine) MPFTA Project Bastar M.P. for various type of help during the survey. Thanks are also due to Shri M.K. Verma for carefully typing the manuscript.

SUMMARY

The survey of charcoal root-rot in *Pinus caribaea* caused by *Macrophomina phaseolina* (Tassi) Gold was conducted by random sampling technique in pine plantations of Bastar. The disease percentage was found to vary from compartment to compartment depending upon the land topography. Due to excessive run-off and lack of moisture on steep slopes as also under water logging conditions, the result of moisture stress causes maximum damage to plants on account of pathogen attack. Control measures have been suggested to prevent and minimize the disease menace in nursery and in plantation area.

बस्तर (मध्य प्रदेश) के पाइनस कैरिबिया रोपवनों में काली जड़ें-अपक्षयण रोग के आपात के सम्बन्ध में एक प्रेक्षण

लेखक जमालुद्दीन, बी०एस० डडवाल व के०के० सोनी

सारांश

मैक्रोफामिनो फैजियोलिना (तासी) ग्वायड से पाइनस कैरिबिया में होने वाले काली-जडें-अपक्षयण का सर्वेक्षण बस्तर के चीड़ बनों में समसंभाविक न्यादर्शन रीति से कराया गया। भूमि के तल रूप के अनुसार एक अनुखण्ड से दूसरे अनुखण्ड में रोग के प्रतिशत में अन्तर होता पाया गया। अधिक ढलवा भूमि में अत्याधिक अपवाह और नमी की कमी होने से और इसके साथ कहीं-कहीं जलमग्नता रहने से, नमी पर पड़ा हुआ दबाव रहने पर यह रोगजन लग जाने पर पौधों को अधिकतम हानि पहुँचाता है। रोपणियों और रोपवनों में यह रोग कैसे रोका जाय, कैसे इसे घटा कर न्यूनतम बनाया जाए, इसके लिए नियन्त्रण उपाय भी सुझाए गए हैं।

References

Jamaluddin, V.S. Dadwal and K.K. Soni (1982). Studies on charcoal root-rot of *Pinus caribaea*. *Indian For.* **108** (9) : 618–622.

Seymour, C.P. and C.E. Cordel (1979). Control of charcoal root-rot with methyl bromide in forest nurseries. *South. Jour. App. For.* **3** : 104–108.

A NEW DEFOLIATOR OF *CEIBA PENTANDRA* (L.) GAERTN. FROM TAMIL NADU, INDIA

M.L. THAKUR* AND S.R. MADHAVAN PILLAI
Disease-Insect Survey,
Forest Research Centre, Coimbatore

Introduction

Ceiba pentandra (L.) Gaertn. has gained a wide popularity under the social forestry programmes, especially in Kerala and Tamil Nadu, as a good source of silk cotton and raw material for wood based industries. This species in finding great favour with the rich farmers, who have started growing it along the boundaries of their farms, fallow lands as well as mixed plantations under agro-forestry conditions. During the course of insect survey of some plantations in Erode (Tamil Nadu), many young plants of this species were found severely defoliated by the larvae of *Pericallia ricini*. Fabr. This appears to be anew pest record for this species and is being reported here.

The pest

Pericallia ricini Fabr. (Lepidoptera : Arctiidae) popularly known as woolly bear, is a common polyphagous agricultural pest, occurring all over the Indian sub-continent, especially in the foot hills of Western Ghats (South India), where it attacks, at times rather severely, its main host bannana. Apart from this, it enjoys a very wide range of host species, such as brinjals, castor, cucurbits, sweet potatoes, drumsticks and many other plants. It has also been reported to defoliate *Cassia tora*, *Colebrookea oppositifolia*, *Dahlia variabilis*, *Impatiens* sp., *Lantana camara*, *Ricinus communis*, *Rosa indica*, *Santalum album*, *Sesbania grandiflora*, *Solanum melongena*, *Campsis grandiflora*, *Tetrameles nudiflora* and *Zea mays*. (Beeson, 1941 ; Bhasin, *et al.*, 1959 ; Mathur and Singh, 1960, 1961).

Observations

The larvae were collected from the field and were reared in the laboratory on *Ceiba pentandra* leaves. The observations recorded here are based partly on our reared material and partly from literature.

The moth is of medium size, stout; head and thorax greyish; forewing fuscous; with pale ringed black spots; hind wing crimson pink; with dark spots; abdomen crimson with black vertical stripes. The female lays 150–170 egg in clusters on the lower surface of leaves just 3-4 days after emergence. The eggs hatch in about 4 days in South India. The larvae are known as black hairy caterpillars. They are dark brown or blackish brown in colour and are covered with long thick reddish brown hairs. There are seven

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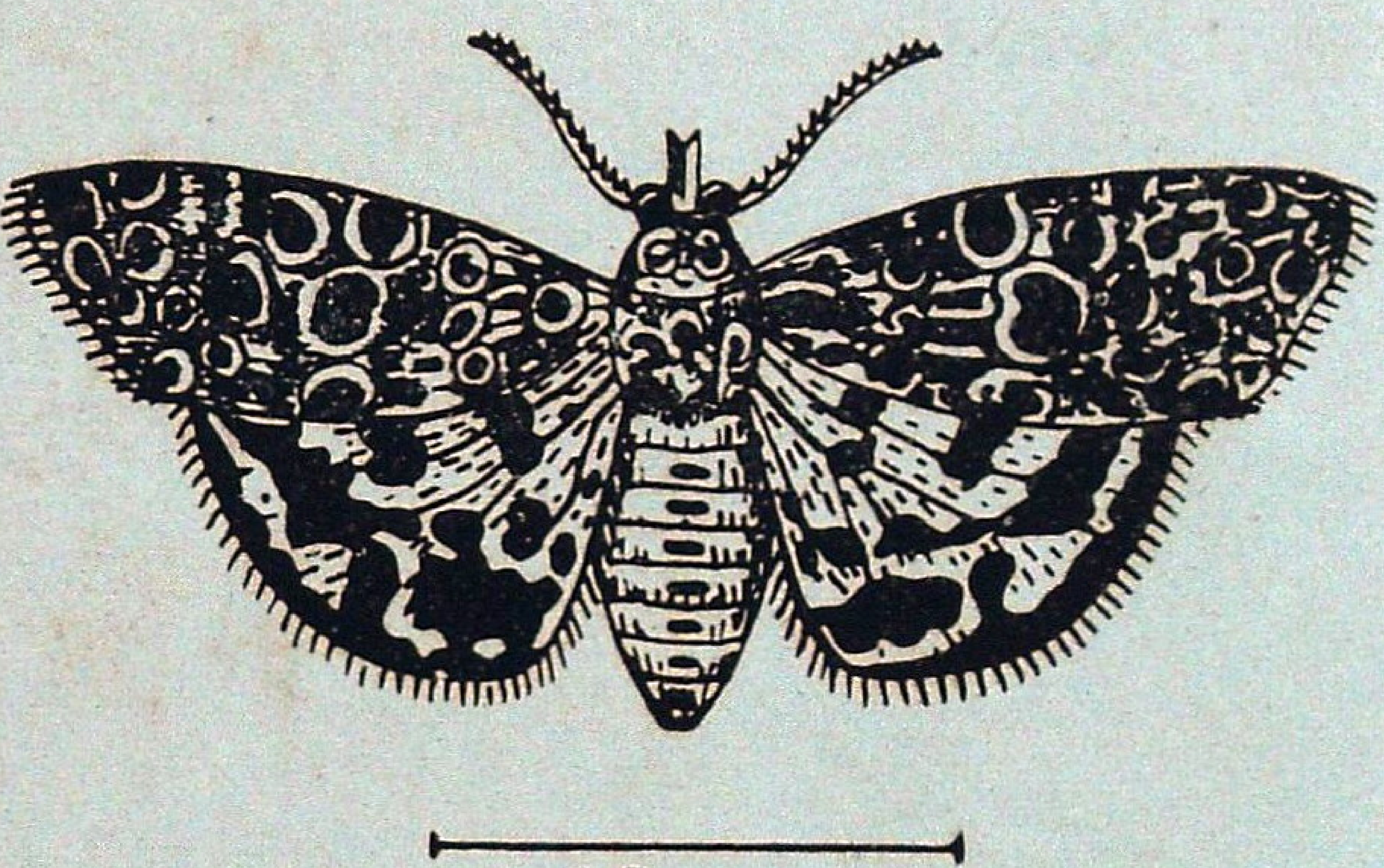
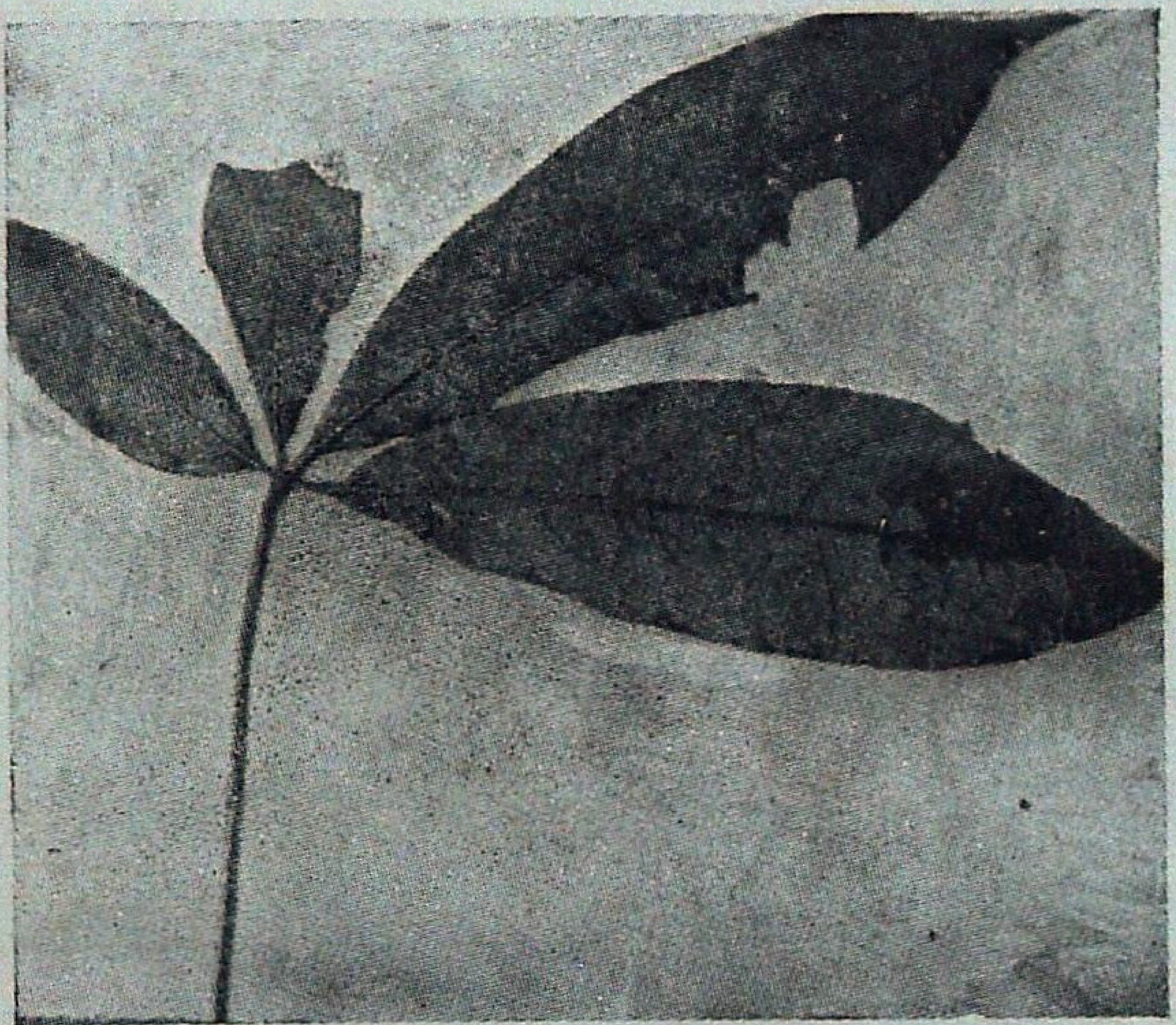
* Present address : Forest Entomology Branch, Forest Research Institute and Colleges, Dehra Dun.

Fig. 1



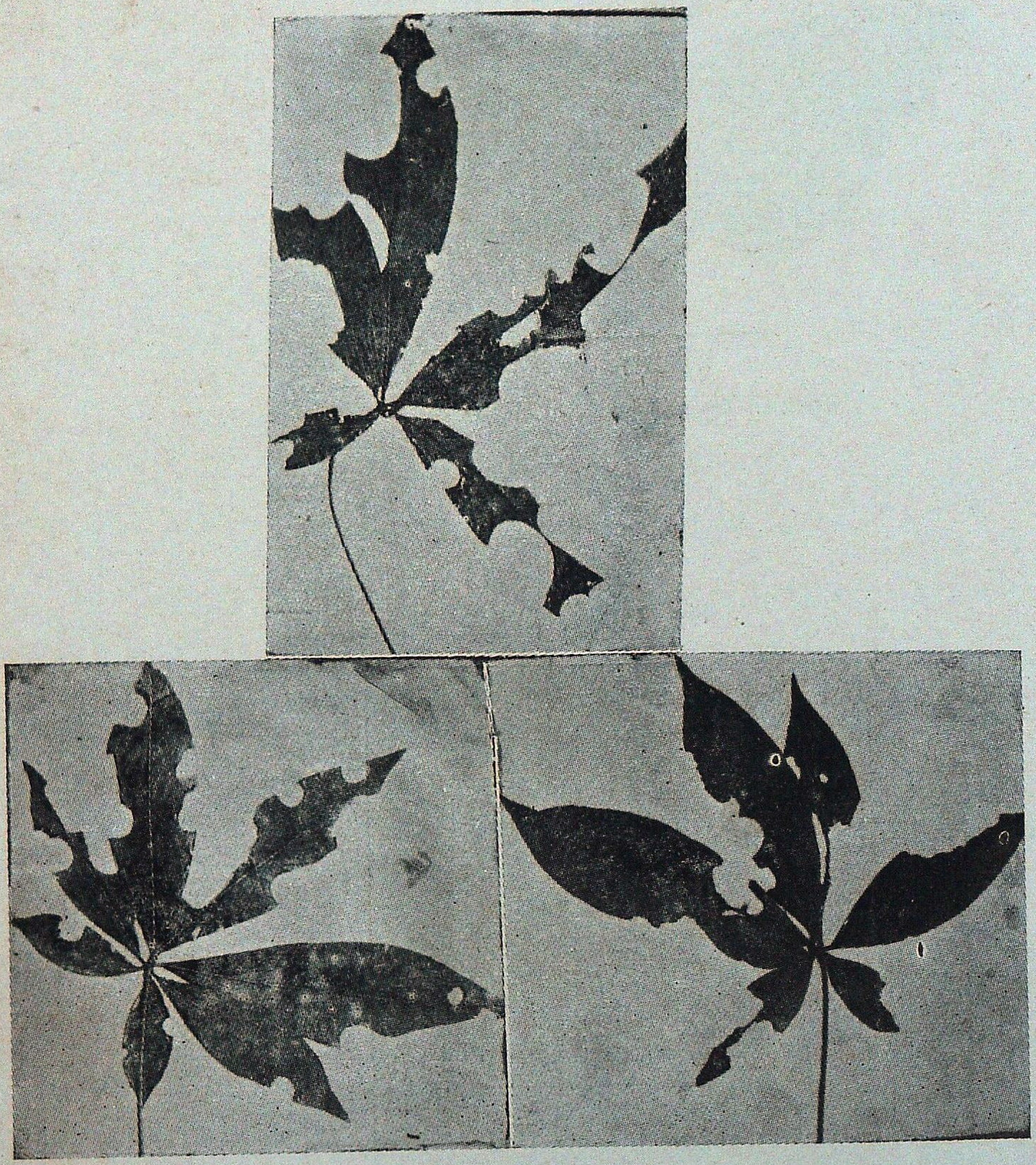
Moth of *Pericallia ricini*. Fabr.

Fig. 2



Leaf of *Ceiba pentandra* skeletionised by Ist and IInd stage larvae of *Pericallia ricini* Fabr.

Fig. 3



Leaves of *Ceiba pentandra* defoliated by later stages of larvae of *Pericallia ricini* Fabr.

instars with 26-32 days larval period. The pupae are reddish brown in colour and squat on the host plant in a cocoon under leaf folds for 10-12 days. The entire life cycle spans over a period of 40 days (Nair, 1975).

Feeding habit

The caterpillars are nocturnal in habit and feed voraciously. They are normally a minor pest, but occasionally cause serious damage to the foliage of the host plant. During the early stages of their development, the larvae feed on the parenchymalous tissues of leaves, leaving the basal network (veins) which impart an appearance of a skeletonized leaf (Fig. 2). However, as the larvae grow in age and size, they eat away the entire leaf tissue (Fig. 3). In case of severe infestation, the entire plant is defoliated, thus affecting the growth.

Enemy complex

So far, it has been reported that in nature, the larvae of *Pericallia ricini* Fabr. are parasitized by *Apantelas ricini* Bhat; *Euplectrus* sp., *Hemicospilus rufus* Tosq., *Meteorus* sp., *Sturmina* sp., *Thelaira nigripes* Fabr., but none of them has been found to control the pest population effectively. (Butani and Verma, 1981).

Further studies are contemplated to work out the enemy complex of the pest. The other methods, advocated for controlling the pest, are hand-picking of egg masses and caterpillars and then prompt destruction in the initial stages of infestation. However, in case of severe infestation, the plantation may either be sprayed with 0.1 to 0.2% of water solution of endosulfan (E.C.) or dusted with 5% carbaryl or 10% of BHC dust.

SUMMARY

Pericallia ricini Fabr. is recorded as new pest for _Ceiba pentandra_, from Tamil Nadu. Feeding habit, enemy complex and control measures have been discussed.

तामिलनाडु, भारत से सीबा पेंटांड्रा (लि०) गार्टन० का एक नया निष्पत्रक कीट

लेखक एम०एल० ठाकुर व एस०आर० माधवन पिल्लै

सारांश

तामिलनाडु से सीबा पेंटांड्रा के नये ताशिकीट के रूप में पेरिकैलिया रिसिनाई फैब्रि० को अभिलिखित किया गया है। पोषण की आदतें, शत्रुगण और नियन्त्रण उपायों पर भी विचार किया गया है।

References

Beeson, C.F.C. (1941). ***The ecology and control of the Forest insects of India and the neighbouring*** countries; 1008 (Vasant Press, Dehra Dun. Reprinted 1961 Govt. of India Publications)

Bhasin, G.D.; M.L. Roonwal and Balwant Singh (1959). A list of insect pests of forest plants in India and the adjacent countries.—*Indian For. Bull.* (*N.S.*) (*Ent.*), 171 (2) : 1–126.

Butani, D.K. and Sashi Verma (1981). Insect pest of vegetables and their control.—*Pesticide*, **15** (9) : 33–37.

Mathur, R.N. and B. Singh (1960). A list of insect pests of forest plants in India and the adjacent countries.—*Indian For. Bull.* (*N.S.*) (*Ent.*), **171** (4-7) : 1-165; 1-91; 1-148; 1-133.

... ...(1961). A list of insect pests of forest plants in India and the adjacent countries.—*Indian For. Bull.* (*N.S.*) (*Ent.*), **711** (7-9) : 1-130; 1-88; 1-116.

Nair, M.R.G.K. (1975). *Insects and mites of crops in India.* 404 pp. (Indian Council of Agricultural Research, New Delhi)

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CONSTRUCTION OF VOLUME TABLES—A GENERALISED APPROACH

K.P. UNNIKRISHNAN AND RAVENDRA SINGH
Statistical Branch,
Forest Research Institute and Colleges, Dehra Dun (India)

Introduction

Standard regression techniques which are based on the Method of Least squares have gaind wide acceptance for the construction of volume equations. A variety of equations have been proposed and investigated to arrive at the function which predicts the volume of a tree based on diameter at breast height (d.b.h.) and height measurements with minimum error (Schumacher and Hall, 1933, Spur, 1952). Considerable difference of opinion persists, however, regarding not only the function to be used, but the proper criterion of comparison (Spurr, 1952). Spurr achieved excellent results, using the combined variable function $V=a+b\,D^2H$.

Mayer (1953) while discussing the use of algebraic equations to express the volume function, pointed out that the observed volume should be weighted, since the absolute variation of volume per tree was much greater for large trees than for small trees. He recommended the Logarithmic volume equation because all values are automatically assigned their proper weights by Logarithmic Transformation. Cunia (1964), however, suggested the method of weighted least squares for the determination of regression coefficients other than Logarithmic transformations and he argued "that by taking logarithms we automatically replace the estimation of the Arithmatic mean by the Geometric mean. Because the first one is always larger than the second one, the estimated volume tables are diffinitely biased".

Recently however, mensurationists have begun to consider more complicated algebraic expressions because of the comparative ease with which numerical relationships may be analysed on high speed electronic computers. In addition, they have become more interested in some of the subtler aspects of regression theory in relation to volume estimation, especially the conditions which lend it statistical validity.

Underlying assumptions of Regression analysis and the behaviour of volume data vis-a-vis these conditions

The basic assumptions in the theory of Regression analysis which validated the tests of significance of Regression coefficients are :

(1) The sampling errors are independent and normally distributed.

(2) The population variance of the dependent variable is constant for all values of the independent variables. This is other-wise known as the property of Homoscedasticity.

If the situation does not satisfy either of these conditions then it renders invalid not only tests of significance but also calculations of confidence limits for estimated population parameters.

By suitable random sampling methods in the field, while collecting sample data, the first condition can be made to satisfy. But in numerous cases of volume data, the second condition was found to be not satisfied. It was observed that the standard error of the residuals from arithmetic volume equations tends to vary with the size of the trees (Meyer, 1953 and Jhonson, 1959). The variation in volume per tree is larger for trees in big diameter classes compared to small trees thus violating the uniformity of variances assumptions.

Ordinary Least square methods are efficient only in cases where homoscadasticity exists. When such a situation does not exist some corrections are to be effected in the data to bring in the property of homogeneity of variance. Another way of correcting for the non-homogeneity of the variance, and apparently a better one since it is unbiased, is to estimate the regression coefficients by the method of weighted least squares (Cunia, 1964).

Theoretically weights are to be employed that are inversly proportional to the variance of residuals. But in practice it may be difficult to determine the most appropriate weight that fits a particular equation. This leaves us with the option of trying a variety of weights and to choose the best weight based on certain criteria. It has been shown that the variance of the volume tends to be proportional to (D^2H^2) or $(D^2)^2$ or $(D^2H)^2$ in the various diameter and height classes (Cunia, 1964).

Furnival Index—for the comparison of equations :

When we compare a variety of regression models some criteria is to be adopted to pick out the best model from the set. Usually one is tempted to use either the sizes of the standard deviation from Regression or the Coefficient of Determination (R^2) for comparison purposes. But these criterison are not suitable in the case of weighted and transformed models because there the dependent variable differ from one model to another. Comparison in such cases are made possible by an Index developed by George (1961).

Computation of Furnival Index :

First the root mean square of the residuals are obtained by fitting each equation to the data. The Geometric means of the derivatives of the various dependent variables (which are either transformed or weighted) with respect to volume are computed next. The computed root mean square values are multiplied by a factor which is the inverse of the appropriate Geometric mean to give the Furnival Index.

Thus the values of the factor in the case of the following dependent variables will be :

Dependent Variable	*Factor*
V	1
$\text{Log } V$	The Geometric mean of V.
V/D^2	The Geometric mean of D^2.
V/D^2H	The Geometric mean of D^2H.

The various Geometric means are calculated as antilog $\Sigma \frac{\log V}{n}$, antilog $\Sigma \frac{\text{Log } D^2}{n}$ antilog $\Sigma \frac{\text{Log } D^2H}{n}$ respectively.

Computer Program 'VOLTAB' :

The tremendous amount of numerical calculations involved in the comparison of different regression models (unweighted, weighted and transformed) were made possible with the advent of electronic computers. The computer program 'VOLTAB' originally developed at the Commonwealth Forestry Institute, Oxford and now finalised in 'System-332' is a versatile one which has incorporated all the complicacies involved in the search for the best fit regression model and the Generation of volume tables.

The program allows comparison of fifteen of the most commonly used regression models, six of which are for single independent variables and the remaining nine for use with two independent variables. The independent variables are either d.b.h. or height or derivatives of them.

The fifteen different models are :

1. $V = b_0 + b_1 D$
2. $V = b_0 + b_1 D + b_2 D^2$
3. $V = b_0 + b_1 D^2$
4. $V = b_0 + b_1 D^2 H$
5. $V = b_0 + b_1 D^2 + b_2 H + b_3 D^2 H$
6. $V = b_0 + b_1 D^2 + b_2 DH + b_3 D^2 H$
7. $\text{Log } V = b_0 + b_1 \text{Log } D$
8. $\text{Log } V = b_0 + b_1 \text{Log } D + D_2 \text{Log } H$
9. $V/D^2 = b_0 + b_1 (1/D) + b_2 (1/D^2)$
10. $V/D^2 = b_0 + b_1 (1/D^2)$
11. $V/D^2H = b_0 + b_1 (1/D^2 H)$
12. $V/D^2 = b_0 + b_1 (1/D^2) + D_2 (H/D^2) + b_3 H$
13. $V/D^2H = b_0 + b_1 (1/H) + b_2 (1/D^2) + b_3 (1/D^2H)$
14. $V/D^2 = b_0 + b_1 (1/D^2) + b_2 (H/D) + b_3 H$
15. $V/D^2H = b_0 + b_1 (1/H) + b_2 (1/D) + b_3 (1/D^2H)$

The input requirement for the program is a matrix of data consisting of d.b.h. (or Girth), Height and Volume for a sample of trees.

The program produces

1. Stand table for given classes of Diameter and height.
2. Correlation matrix of all regression variables used.
3. Regression Statistics for the different 15 models given above.
4. Best fit to data based on Furnival Index.
5. Confidence limits for volume for specified values of D and H from either the best fit model or from any other specified model.
6. Volume tables at specified intervals of D and H with or without confidence limit from either best model or specified model including use of conversion factors.

Illustrative Example :

For illustrating the utility of the computer program developed real data on volume, diameter and height based on measurements of 56 sample trees were considered. The trees are belonging to the species ***Dipterocarpus turbinats***, Gaertn-Syn. ***Dipterocarpus indicus***-Bded (Gurjan oil tree) from Karnataka State.

The Gurjan oil tree is a species of Southern Tropical Wet Evergreen Forests of India. This data was collected from Kodagu (Coorg) and Shimoga Forest Divisions of Karnataka by Dr. S N. Rai, the then Silviculturist, Southern Zone, Karnataka State. The diameter ranged from 9.3 cms to 107.0 cms (o.b.) and height from 15.9 m to 38.0 m. The stem volume of the trees were measured by dividing them into logs of suitable lengths. The volume of logs were calculated by Huber's formula and added to get the volume of the tree.

The data was processed using the Computer program 'VOLTAB'. A summary of the results obtained is presented in Table 1.

The model with the smallest Furnival Index is taken to give the best fit. A comparison of the Furnival Indices for the different models gives that it is least for model 8 with a Furnival Index of 0.2212. Thus the best fit equation is

$$\text{Log } V = -.4649 + 2.1141 \text{ Log } D + 0.9175 \text{ Log } H$$

Where V = Stem volume over-bark in m^3

D = d.b.h. in m.

H = Total tree height in m.

with SE (b_1) = 0.0665 and SE (b_2) = 0.1596

The analysis of variance table and the related statistics for model No. 8 are given in Table 2.

Table 1

Model No.	Furnival Index	R	R^2	S.D. Residuals	S.D.%
1	1.41107	.9295	.8640	1.4111	47.364
2	1.32503	.9393	.8823	1.3250	44.475
3	1.35728	.9350	.8742	1.3573	45.558
4	0.828191	.9763	.9532	0.8282	27.799
5	0.697833	.9839	.9680	0.6978	23.423
6	0.695248	.9840	.9682	0.6952	23.336
7	0.279244	.9887	.9776	0.1921	51.320
8	0.221241	.9931	.9862	0.1522	40.660
9	0.321702	.7240	.5240	2.4522	21.221
10	0.385939	.5496	.3020	2.9418	25.459
11	0.240886	.2647	.0701	0.07087	16.362
12	0.267801	.8284	.6764	2.0413	17.666
13	0.2410	.3217	.1035	0.0709	16.371
14	0.267815	.8224	.6763	2.0414	17.667
15	0.241104	.3207	.1029	0.0709	16.377

Table 2

Analysis of Variance

Source of Variation]	Degrees of freedom	Sum of squares	Mean Sum of squares	F-ratio (2, 5/3)			
				Observed	'Expected		
					5%	1%	.1%
Regression	2	87.7359	43.8679	*** 1894.46	3.17	5.04	7.76
Residual	53	1.2273	0.023156				
Total	55	88.9632					

*** Significant at 0.1% level of probability.

Coefft. of Determination (R^2) = 0.98620
Correlation Coefft. (R) = 0.99308
Standard Deviation of Residuals= 0.152171

The regression parameters are found to be highly significant (at 0.1% level of probabiltiy).

The stand table, based on which the regression parameters were estimated is presented in Appendix-I. Appendix-II gives the volume table generated with 95% confidence intervals for volume. (Table 1 and Table 2).

Note : An examination of Table I reveals the interesting thing that model No. 8 is the best fit to the data not only in terms of Furnival Index but also with respect to the Coefficient of Determination. It has got a Coefficient of Determination of 98.62%.

Conclusion

Construction of regional as well as general volume tables are made easier by the employment of the computer program 'VOLTAB'. It offers facilities for the construction of stand tables, confidence limits for volume for various diameter and height classes alongwith the Generation of volume tables.

The illustrated example corroborates the intuition that transformed and weighted models (in this example the model that gave best fit is $\text{Log } V = -.4649 + 2.1141 \text{ Log } D + 0.9175 \text{ Log } H$) are better than the usual linear model $V = a + b\,D^2 H$, which is being widely used by mensurationists in India.

Acknowledgement

The authors wish to thank Dr. S.N. Rai, Lecturer, Indian Forest College, for providing original data for the illustrated example given in the paper. The help rendered by Shri Sunil Bhat, the software Engineer at National Forest Computer Centre, Dehra Dun in the finalisation of the Computer program is gratefully acknowledged. Finally the authers are indebted to the President, Forest Research Institute and Colleges for creating an atmosphere conducive for such research work.

SUMMARY

The present paper outlines the development of a volume table construction method based upon statistical principles. It lays special emphasis to the usual conditions which underlie the theory of regression and how these can be met in finding out best fit volume equations. Description of a computer program developed on these lines and finalised for 'System-332', Computer is an added feature. Stand table and volume tables constructed for sample data for the species *Diperocarpus indicus* have been included in the paper.

Appendix I

Stand Table—Number of trees

Diameter (m)	Height Classes (m)									
	15.5	18.5	21.5	24.5	27.5	30.5	33.5	36.5	GT 38.0	Total
.215	3	3	3	1	2	0	0	0	0	12
.285	0	1	5	1	2	1	0	0	0	10
.355	0	0	2	5	3	1	0	0	0	11
.425	0	0	0	1	2	2	0	0	0	5
.495	0	0	0	0	1	3	1	1	0	6
.565	0	0	0	1	0	1	1	0	0	3
.635	0	0	0	0	0	0	2	0	0	2
.705	0	0	0	0	0	0	1	0	0	1
.775	0	0	0	0	0	0	0	0	0	0
.845	0	0	0	0	0	1	1	1	0	3
GT. 88	0	0	0	1	0	0	1	1	0	3
Total	3	4	10	10	10	9	7	3	0	56

Appendix
Table

Volume Table—*Dipterocarpus turbinats,*
Total Stem (Wood
Height

Diameters (cm)	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0
10	.0326	.0400	.0472	.0544	.0615			
12	.0479	.0587	.0694	.0800	.0904			
14	.0663	.0814	.0962	.1108	.1252			
16	.0879	.1079	.1276	.1469	.1661			
18	.1128	.1384	.1636	.1885	.2131			
20	.1409	.1730	.2045	.2355	.2662	.2966	.3267	.3566
22	.1724	.2116	.2501	.2881	.3256	.3628	.3996	.4362
24	.2072	.2543	.3006	.3463	.3914	.4361	.4803	.5242
26	.2454	.3012	.3560	.4101	.4636	.5165	.5689	.6209
28	.2871	.3523	.4164	.4797	.5422	.6041	.6654	.7262
30	.3321	.4076	.4818	.5550	.6274	.6989	.7699	.8402
32	.3807	.4672	.5522	.6361	.7191	.8011	.8824	.3631
34	.4327	.5311	.6278	.7231	.8174	.9107	1.0031	1.0948
36	.4883	.5993	.7084	.8160	.9224	1.0276	1.1319	1.2354
38	.5474	.6718	.7942	.9148	1.0341	1.1521	1.2690	1.3850
40	.6102	.7488	.8851	1.0196	1.1525	1.2840	1.4143	1.5436
42	.6764	.8301	.9813	1.1304	1.2777	1.4235	1.5680	1.7113
44	.7464	.9159	1.0827	1.2472	1.4098	1.5706	1.7301	1.8882
46	.8199	1.0062	1.1894	1.3701	1.5487	1.7254	1.9005	2.0742
48	.8971	1.1009	1.3014	1.4991	1.6945	1.8878	2.0794	2.2695
50			1.4187	1.6342	1.8472	2.0580	2.2669	2.4740
52			1.5413	1.7755	2.0069	2.2359	2.4628	2.6879
54			1.6693	1.9229	2.1736	2.4216	2.6674	2.9112

II
1

Gaertn.—Syn. *Dipterocarpus indicus* Bedd.
(with Bank) in m^3
(m)

24.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0	42.0
.9101	.9794	1.0483							
1.0431	1.1226	1.2016							
1.1857	1.2761	1.3659							
1.3380	1.4400	1.5413							
1.5001	1.6144	1.7280							
1.6719	1.7993	1.9259	2.0517	2.1769					
1.8535	1.9948	2.1351	2.2747	2.4134					
2.0451	2.2009	2.3558	2.5097	2.6628					
2.2466	2.4178	2.5879	2.7570	2.9252					
2.4581	2.6454	2.8315	3.0166	3.2006					
2.6797	2.8839	3.0868	3.2885	3.4891	3.6887	3.8873	4.0850		
2.9113	3.1332	3.3536	3.5728	3.7907	4.0075	4.2233	4.4381		
3.1531	3.3934	3.6321	3.8695	4 1056	4.3404	4.5741	4.8067		

(*Contd.*)

Table 1

Diameters (cm)	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0
56			1.8027	2.0766	2.3473	2.6151	2.8806	3.1438	3.4051
58			1.9415	2.2365	2.5280	2.8165	3.1024	3.3859	3.6673
60			2.0858	2.4027	2.7158	3.0258	3.3329	3.3675	3.9398
62						3.2430	3.5721	3.8986	4.2226
64						3.4681	3.8201	4.1692	4.5157
66						3.7012	4.0769	4.4495	4.8192
68						3.9423	4.3425	4.7393	5.1332
70								5.0388	5.4576
72								5.3480	5.7925
74								5.6669	6.1379
76								5.9956	6.4939
78								6.3341	6.8605
80								6.6823	7.2377
82									
84									
86									
88									
90									
92									
94									
96									
98									

(*Contd.*)

26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0	42.0
3.6646	3.9224	4.1787	4.4337	4.6873	4.9396	5.1909		
3.9468	4.2245	4.5005	4.7751	5.0482	5.3200	5.5906		
4.2400	4.5383	4.8349	5.1299	5.4233	5.7153	0.0060	6.2954	6.5836
4.5444	4.8641	5.1820	5.4981	5.8126	6.1255	0.4371	6.7473	7.0562
4.8598	5.2018	5.5417	5.8798	6.2161	6.5508	6.8840	7.2157	7.5460
5.1865	5.5514	5.9142	6.2750	6.6339	6.9911	7.3467	7.7007	8.0532
5.5244	5.9131	6.2995	6.6838	7.0661	7.4465	7.8253	8.2023	8.5779
5.8735	6.2868	6.6976	7.1062	7.5126	7.9171	8.3198	8.7207	9.1200
6.2339	6.6725	7.1086	7.5422	7.9736	8.4030	8.8303	9.2559	9.6796
6.6057	7.0704	7.5325	7.9920	8.4491	8.9041	9.3569	9.8078	10.0325
6.9888	7.4805	7.9693	8.4555	8.9392	8.4205	9.8996	10.3766	10.6144
7.3833	7.9028	8.4192	8.9328	9.4438	9.9523	10.4584	10.9624	11.3643
7.7892	8.3373	8.8821	9.4240	9.9630	10.4994	11.0334	11.5651	12.0946
	8.7841	9.3581	9.9290	10.4969	11.0621	11.6247	12.1849	12.7427
	9.2431	9.8472	10.4479	11.0455	11.6402	12.2322	12 8217	13.4087
	9.7146	10.3479	10.9808	11.6089	12.2339	12.8561	13.4756	14.0926
	10.1984	10.8648	11.5276	12.1870	12.8432	13.4964	14.1468	14.7944
			12.0885	12.7800	13.4681	14.1531	14.8351	15.5143
			12.6635	13.3878	14.1086	14.8262	15.5406	16.2521
			13.2525	14.0105	14.7649	15.5158	16.2635	17.0081
			13.8556	14.6482	15.4369	16.2220	17.0037	17.7822
			14.4730	15.3008	16.1247	16.9448	17.7613	18.5745

Table

95% confidence limits for
Species—
Height

Diameter (m)	8.0	10	12	14	16	18	20	22
10	.0215 .0493	.0281 .4568	.0349 .0639	.0418 .0708	.0487 .0777			
14	.0445 .0987	.0584 .1134	.0727 .1272	.0874 .1405	.1022 .1535			
18	.0765 .1664	.1005 .1907	.1254 .2135	.1511 .2352	.1772 .2562			
22	.1175 .2529	.1546 .2896	.1933 .3236	.2332 .3559	.2741 .3869			
26	.1678 .3589	.2209 .4106	.2765 .4585	.3339 .5037	.3930 .5468			
30	.2275 .4848	.2996 .5544	.3751 .6189	.4534 .6794	.5340 .7370	.6164 .7926	.6998 .8470	.7828 .9019
34	.2967 .6312	.3908 .7217	.4893 .8054	.5915 .8840	.6970 .9586	.8049 1.0303	.9145 1.1003	1.0241 1.1703
38	.3753 .7985	.4944 .9130	.6190 1.0189	.7484 1.1182	.8818 1.2126	1.0184 1.3033	1.1571 1.3917	1.2959 1.4802
42	.4636 .9871	.6105 1.1288	.7643 1.2598	.9240 1.3829	1.0884 1.5000	1.2566 1.6127	1.4271 1.7229	1.5971 1.8336
46	.5614 1.1974	1.7392 1.3695	.9253 1.5289	1.1182 1.6788	1.3166 1.8216	1.5193 1.9595	1.7241 2.0950	1.9274 2.2322
50			1.1018 1.8266	1.3310 2.0064	1.5665 2.1782	1.8063 2.3447	2.0479 2.5093	2.2864 2.6771
54			1.2940 2.1535	1.5624 2.3666	1.8378 2.5707	2.1176 2.7693	2.3983 2.9667	2.6743 3.1690

2

the Volume given in Table I
Dipterocarpus Indicus
(m)

24	26	28	30	32	34	36	38	40	42.0
.8625	.9337	.9934							
.9602	1.0274	1.1063							
1.1300	1.2242	1.3014							
1.2443	1.3302	1.4336							
1.4300	1.5492	1.6469							
1.5736	1.6823	1.8131							
1.7637	1.9066	2.0279	2.1313	2.2252					
1.9512	2.0870	2.2481	2.4276	2.6175					
2.1219	2.2961	2.4438	2.5714	2.6870					
2.3786	2.5459	2.7405	2.9561	3.1845					
2.5136	2.7183	2.8951	3.0496	3.1898	3.3209	3.4458	3.5661		
2.8567	3.0595	3.2912	3.5461	3.8165	4.0971	4.3853	4.6794		
2.9363	3.1737	3.3819	3.5660	3.7334	3.8898	4.0384	4.1812		
3.3859	3.6283	3.9009	4.1989	4.5148	4.8432	5.1809	5.5259		

(*Contd.*)

Table 2

Diameter (cm)	8.0	10	12	14	16	18	20	22	24
58			1.5018 2.5101	1.8124 2.7598	2.1305 2.9996	2.4530 3.2340	2.7753 3.4680	3.0910 3.7090	3.3901 3.9672
62						2.8124 3.7395	3.1789 4.0140	3.5366 4.2976	3.8752 4 6011
66						3.1959 4.2865	3.6090 4.6054	4.0111 4.9357	4.3917 5.2884
70								4.5146 5.6240	4.9397 6.0298
74								5.0470 6.3630	5.5191 6.8261
78								5.6084 7.1536	6.1300 7.6780
82									
86									
90									
94									
98									

(*Contd.*)

26	28	30	32	34	36	38	40	42
3.6626	3.9047	4.1207	4.3179	4.5019	4.6 66	4.8441		
4.2530	4.5705	4.9154	5.2807	5.6608	6.0520	6.4521		
4.1853	4.4635	4.7138	4.9431	5.1573	5.3603	5.5547	5.7423	5.9241
4.0342	5.3007	5.6966	6.1153	6.5511	7.000	7.4596	7.9281	8.4044
4.7418	5.0584	5.3453	5.6092	5.8557	6.0894	6.3130	6.5285	6.7373
5.6729	6.0924	6.5436	7.0198	7.5155	8.0263	8.5496	9.0833	9.6262
5.3322	5.6896	6.0154	6.3160	6.5973	6.8638	7.1188	7.3643	7.6060
6.4697	6.9466	7.4571	7.9952	8.5549	9.1321	9.7235	10.3270	10.9411
5.9565	6.3570	6.7240	7.0637	7.3820	7.6836	7.9720	8.2496	8.5183
7.3255	7.8639	8.4382	9.0423	9.6 06	10.3184	10.9825	11.6603	12.3503
6.6148	7.0607	7.4711	7.8521	8.2096	8.5486	8.8726	9.1844	9.4860
8.2411	8.8453	9.4876	10.1623	10.8635	11.5865	12.3277	13.0845	13.8551
	7.8006	8.2568	8.6813	9.0803	9.4587	9.8206	10.1687	10.5053
	9.8915	10.6063	11.3559	12.1345	12.9372	13.7603	14.6008	15.4568
	8.5768	9.0809	9.5513	9.9939	10.4141	10.8158	11.2025	11.5759
	11.0033	11.7951	12.6242	13.4847	14.3718	15.2813	16.2103	17.1565
			10.4620	10.9506	11.4146	11.8584	12.2852	12.6978
			13.9679	14.9150	15.8910	16.8918	17.9141	18.9554
			11.4135	11.9501	12.4602	12.9481	13.4175	13.8711
			15.3878	16.4262	17.4960	18.5928	19.7132	20.8545
			12.4057	12.9926	13.5508	14.0851	14.5990	15.0957
			16.8848	18.0191	19.1874	20.3851	21.6086	22.8549

आयतन सारणियाँ तैयार करना—एक सामान्यीकृत अभिदृष्टि

लेखक के०पी० उन्नीकृष्णन व रबेन्द्र सिंह

सारांश

प्रस्तुत अभिपत्र में सांख्यिकीय सिद्धांतों के आधार पर आयतन सारणियां वनाने की रीति का विकास करने की रूपरेखा दी गई है। इसमें उन्हीं आम शर्तों पर विशेष बल दिया गया है जो प्रतीपायन मतवाद में निहित हैं। और यह बताया गया है कि सर्वोत्तम ठीक बैठने वाले आयतन समीकरण ज्ञात करने में इन्हें कैसे पूरा किया जा सकता है। इन्हीं दिशाओं में सिस्टम-३32 के लिये एक संगणक कार्यक्रम विकसित किया और उसे अंतिम रूप दिया गया है। अभिपत्र में डिप्टेरोकार्पस इंडिकस जाति के नमूना आँकड़ों से बनाई हुई वन वृक्ष सारणियां और आयतन सारणियां भी सम्मिलित की गई हैं।

References

Abbell, T.M.B. (1979). Single and Double entry volume tables for Meranti in Jambi Province, Sumatra. The Malaysian *For.* 42 (3).

Burley, J.H.L. Wright and E. Matos (1972). A Volume table for ***P. caribaca. The Commonwealth Forestry Review***. 51 (2), 148, June.

Cunia, T. (1964). Weighted least squares method and construction of Volume tables, *For. Sci.* (10) : 180–191.

Douglas, J. Gerrard (1966). The Constructions of standard tree volume tables by weighted Multiple Regression. University of Toronto, Faculty of Forestry, *Technical Report* No. 6.

Gedney, D.R. and F.A. Johnson (1959). Weighting factors for computing the relation between tree volume and d.b.h. in the pacific North-west, U.S.D.A., Forest Service, Pacific N.W. For. and Range Expt. Sta., Research Note No. 174.

George, M. Furnival (1961). An Index for comparing equations used in constructing Volume tables. *For. Sci*, Vol. 7, Dec.

Honer, T.G. (1965). A new total cubic foot volume function. ***The Forest Chronicle***. 41 (4).

Kinashi, Kenkichi and F.X. Schumacher (1958). A test of the Standard Volume table by multiple regression, Kyushu University, ***Forestry Bullettin*** 30 : 127–133.

Meyer, H.A. (1953). ***Forest Mensuration***, Penn Valley Publishers State College.

Palley, Marshall, N. (1959). Board foot volume tables for young growth coastal redwood. University Cal. School of Forestry. Cal. Forestry and Forests Products No. 11.

Rai, S.N. (1980). Regional volume tables for Gurjan Oil Tree and its certain other relationships (Data from Karnataka). The ***Indian For.*** **106** (8) : 574-577.

Schumacher, F.X. and S.F. Hall— Logarithm expression of timber tree volume. ***Jour. of Agr. Research*** 47.

Spurr, S.H. (1952). ***Forest Inventory***. Ronald Press Co., New York.

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STUDIES ON THE RELATIONSHIP OF CINEOLE CONTENT OF THE OIL AND STOMATA CHARACTERS OF *EUCALYPTUS* HYBRID *(E. TERETICORNIS)* LEAF

S.S. BISEN, V.V. PRABHU* AND K.S THEAGARAJAN*

Wood Anatomy Branch,
Forest Research Institute and Colleges, Dehra Dun (India)

Introduction

Large scale planting of *Eucalyptus* hybrid is being taken up under productive and social forestry programmes on account of its fast growth and adaptability to different soils and climatic conditions. Its biomass yield is very high within a short span of time, resulting in short rotation. It is also good coppicer. While *Eucalyptus* hybrid is mainly regarded as a pulpwood and to some extent as a fuelwood, the leaves and bark are not utilised economically at present. An average yield of foliage per tree is 5.887 kg, yielding 43.75 kg of oil per ha (Verma *et al.* 1978). Even though its leaves contain essential oil consisting of pinenes, cineole and other aromatic chemicals, the oil has not been put to commercial use like that of *Eucalyptus citriodora*.

Earlier investigations have shown that some of the *Eucalyptus* hybrid trees yield 'cineole-rich' oil similar to that of *E. globulus* (blue gum) but it is difficult to distinguish them from others based on morphological characters (Theagarajan and Rao, 1970). The correlation between cineole content and refractive index of the oil though useful for screening of *Eucalyptus* hybrid plantations to locate 'cineole-rich' trees (Theagarajan *et al.* 1970), is time consuming. Several such tree have been identified in selected plantations in the southern states using this technique (Theagarajan and Prabhu, 1981).

In selecting trees for collecting leaf material on a large scale, simple olfactory test is used in the field, which is rather subjective and not infallible. Hence a reasonably rapid objective test based on the epidermal features of the leaves to determine cineole content was thought of, using both light microscope and scanning electron microscope.

Light microscopic studies backed up by SEM investigations indicate that the stomatal characteristics *viz.* stomatal frequency, wax plugging and pattern of cuticle can serve as useful criteria for differentiating the 'cineole-rich' trees from others. The results are presented here.

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* Forest Research Laboratory, Bangalore.

Materials and method

Leaves from *Eucalyptus* hybrid trees growing at Forest Research Laboratory campus were collected for this study. They were of different cineole content and identical age and maturity.

For SEM studies the leaves were fixed for a minimum period of 48 hrs after plucking, in 4% gluteraldehyde prepared in phosphate buffer of pH 6.8. The samples were then washed thoroughly with the buffer, followed by distilled water and ultrasonicated in distilled water to remove the surface contaminants. Specimens were dehydrated in a graded series of alcohol followed by absolute alcohol : amyl acetate (1 : 1) and finally in pure amyl acetate. The drying of the samples was done by 'critical point drying method' using liquid CO_2. The specimens were then coated with carbon followed by gold/palladium and SEM observations were made using a 'Cambridge Stereoscan-S-600' scanning Electron Microscope.

For studying the stomatal frequency both on the dorsal and ventral surfaces of the leaves, epidermal imprints were taken using 'thermocole' solution (9 gm of thermocole' was dissolved in a mixture of 25 ml Benzene and 25 ml Toluene). The leaf was completely dipped in 'thermocole' solution and dried in air after having been taken out of the solution. The 'thermocol' coating was peeled off carefully after drying. This peel (imprint) was observed under light microscope. The number of stomata in a unit area was counted under the light microscope to find out the variations in stomatal density from each leaf, hundred readings were taken separately from the dorsal and ventral surfaces all along the length of the leaf.

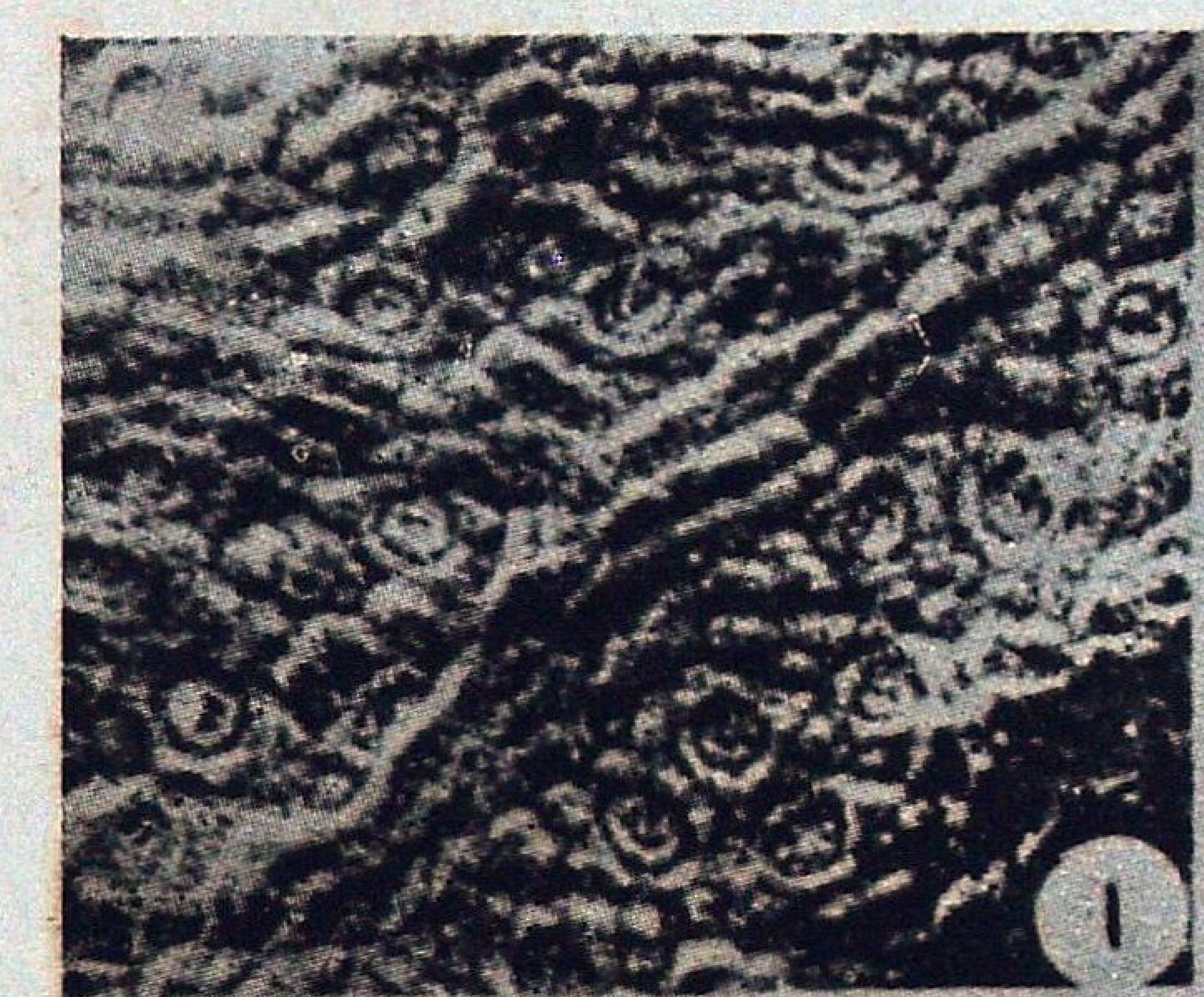
Results and discussion

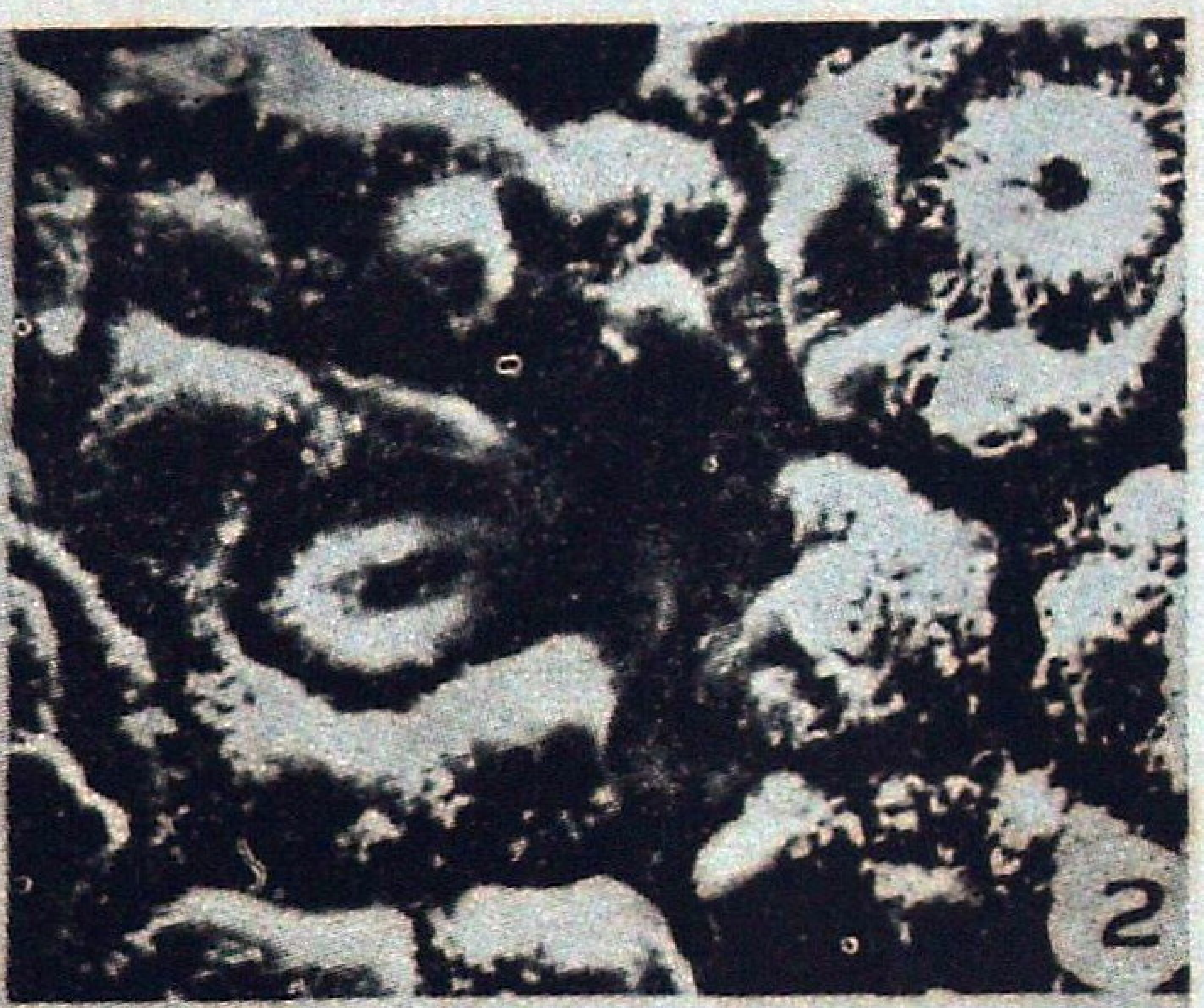
The SEM and LM observations have revealed that there is a significant difference in the stomatal frequency between the 'cineole-rich' (>60% cineole) and 'cineole-poor' (<60% cineole) oil yielding trees. The 'cineole-rich' oil yielding leaves have lesser number of stomatas (Fig. 1) when compared to 'cineole-poor' ones (Fig. 7 and 8).

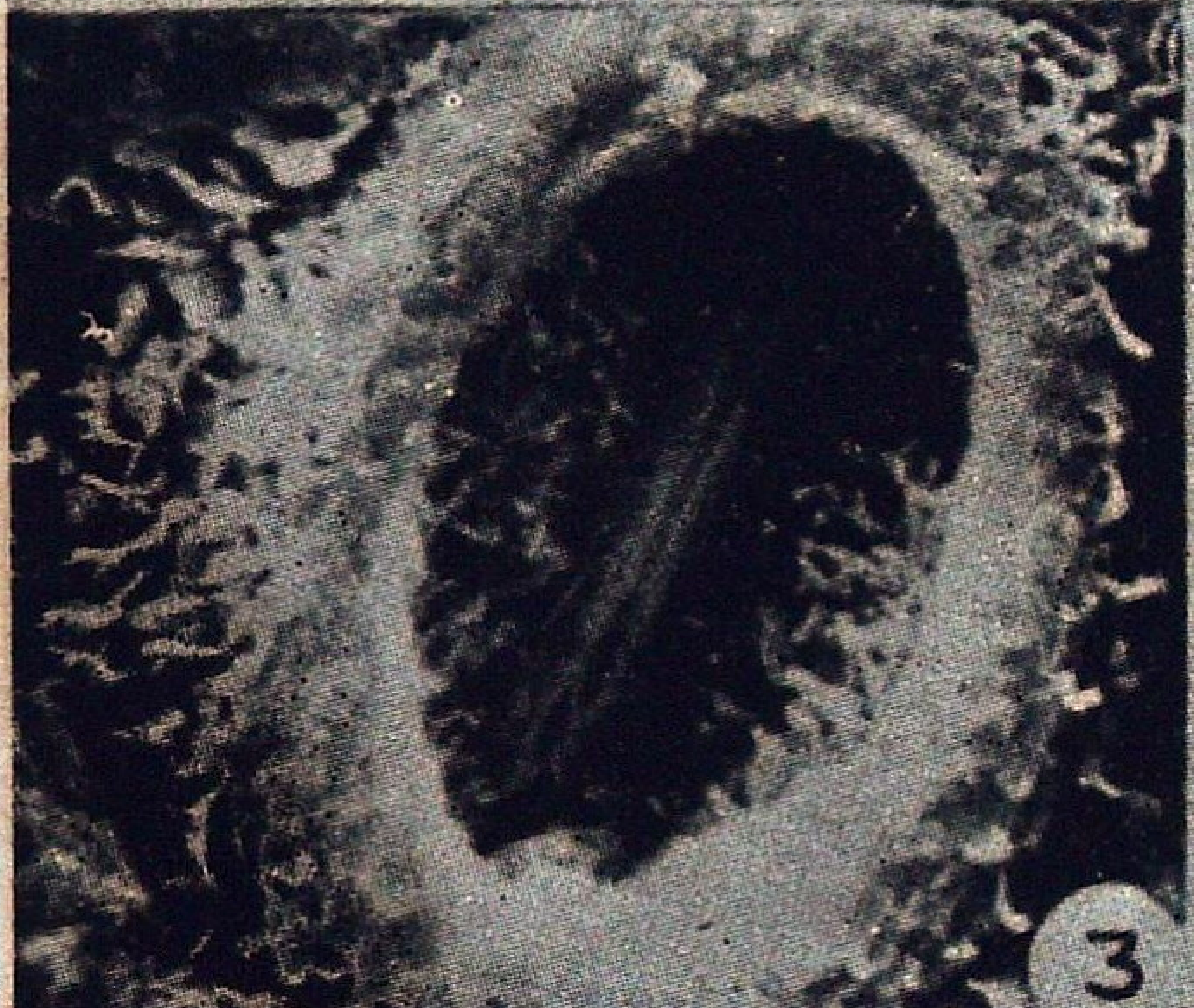
Stomatal densities were also compared among the samples belonging to different classes *viz.* 'cineole-rich' and 'cineole-poor' using a 't' test. Results of the analyses are given in Table 1. There is thus ample evidence to show that 'cineole-rich' and 'cineole-poor' oil yielding trees differed significantly among themselves with respect to stomatal densities.

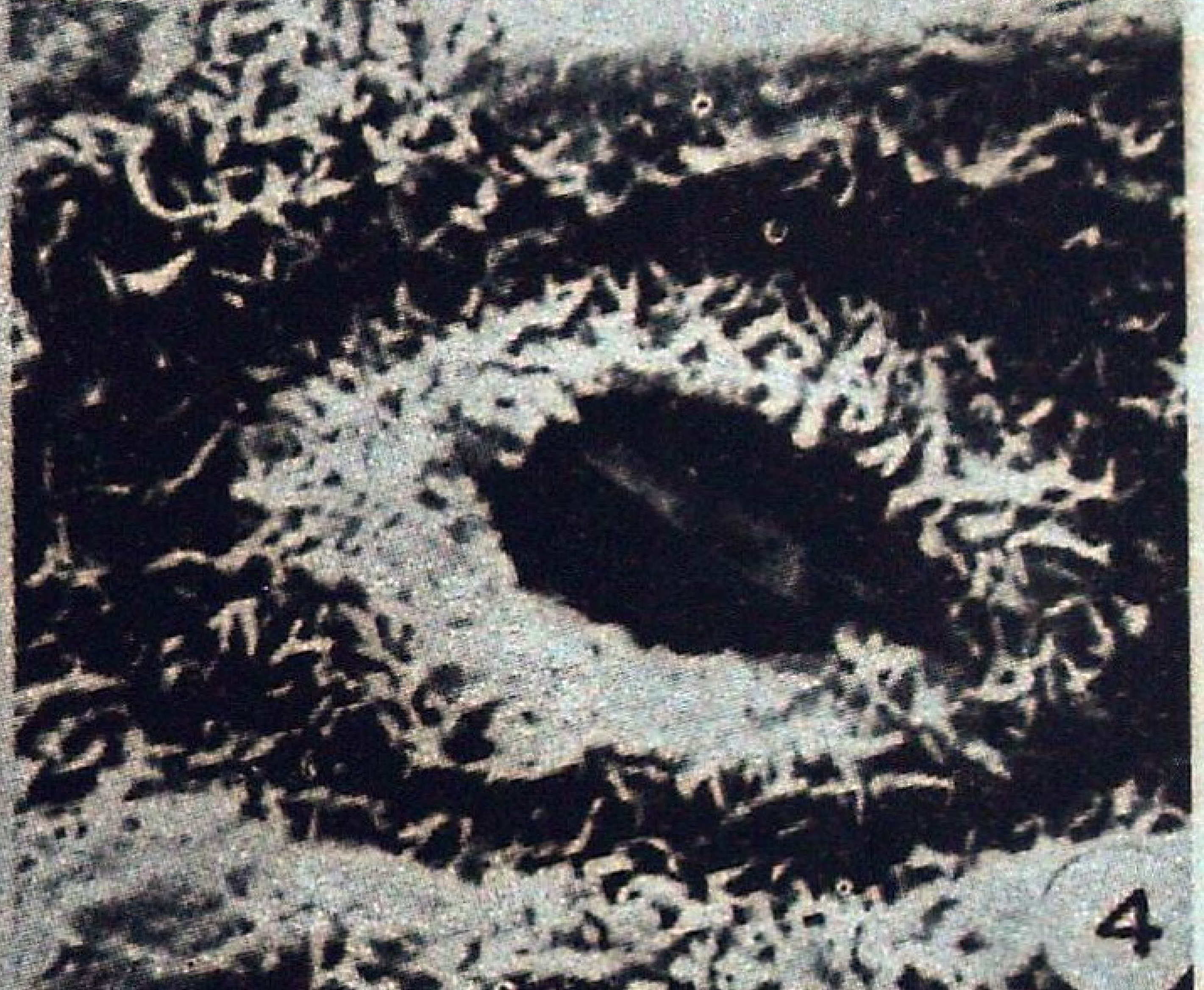
The data were further analysed to estimate the mean stomatal densities and their confidence limits for 'cineole-rich' and 'cineole-poor' varieties separately. One hundred random samples were selected from the two sets of observations *viz.* 'cineole-rich' and 'cineole-poor'. Mean stomatal densities were estimated based on these observations. Confidence limits were calculated using the expression $X \pm t-95\hat{\sigma}/\sqrt{n}$ for 95% confidence limits and $X \pm t-99\hat{\sigma}/\sqrt{n}$ for 99% confidence limits. Results are given in Table 2.

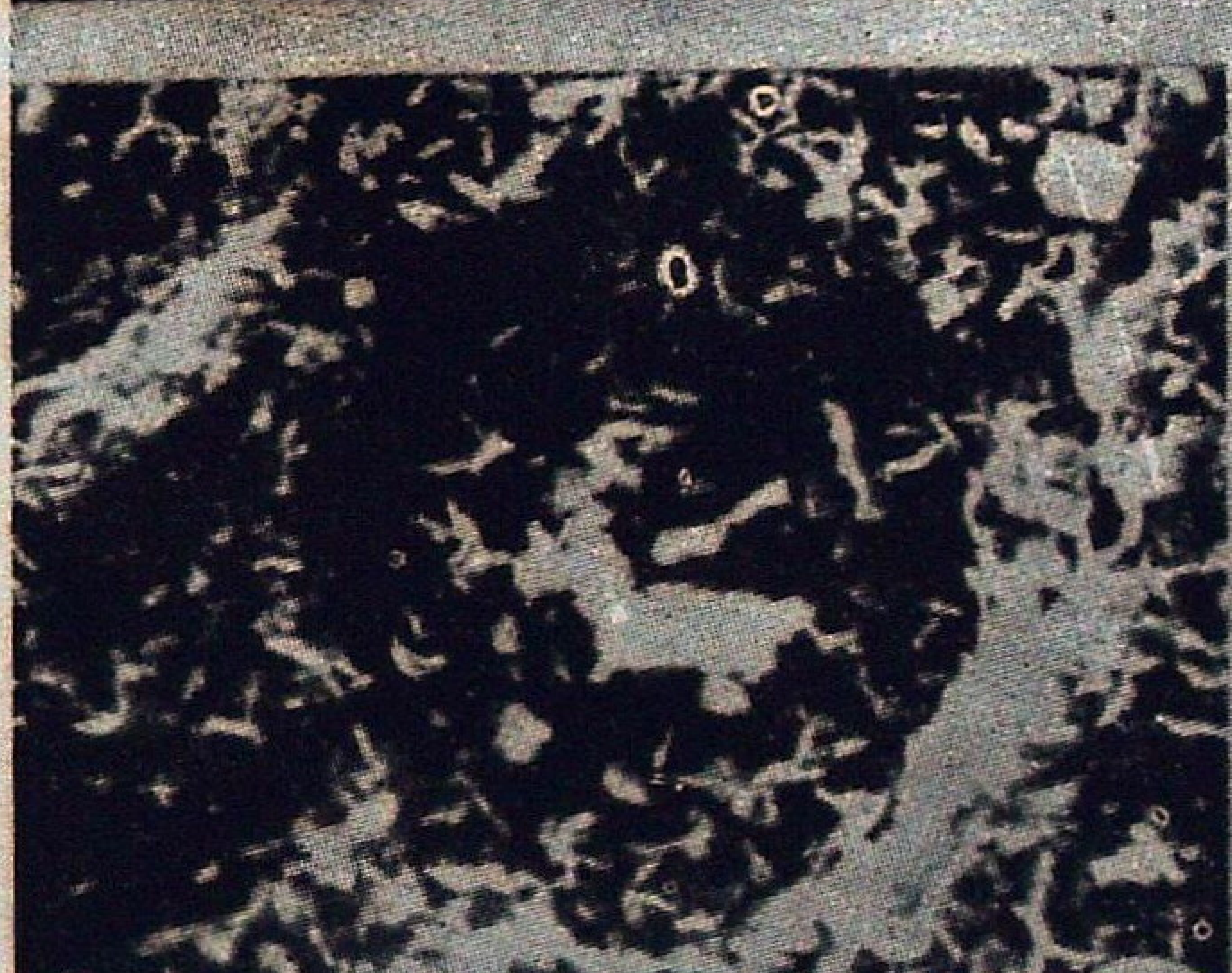
The scanning electron microscopic observations further revealed the charac-











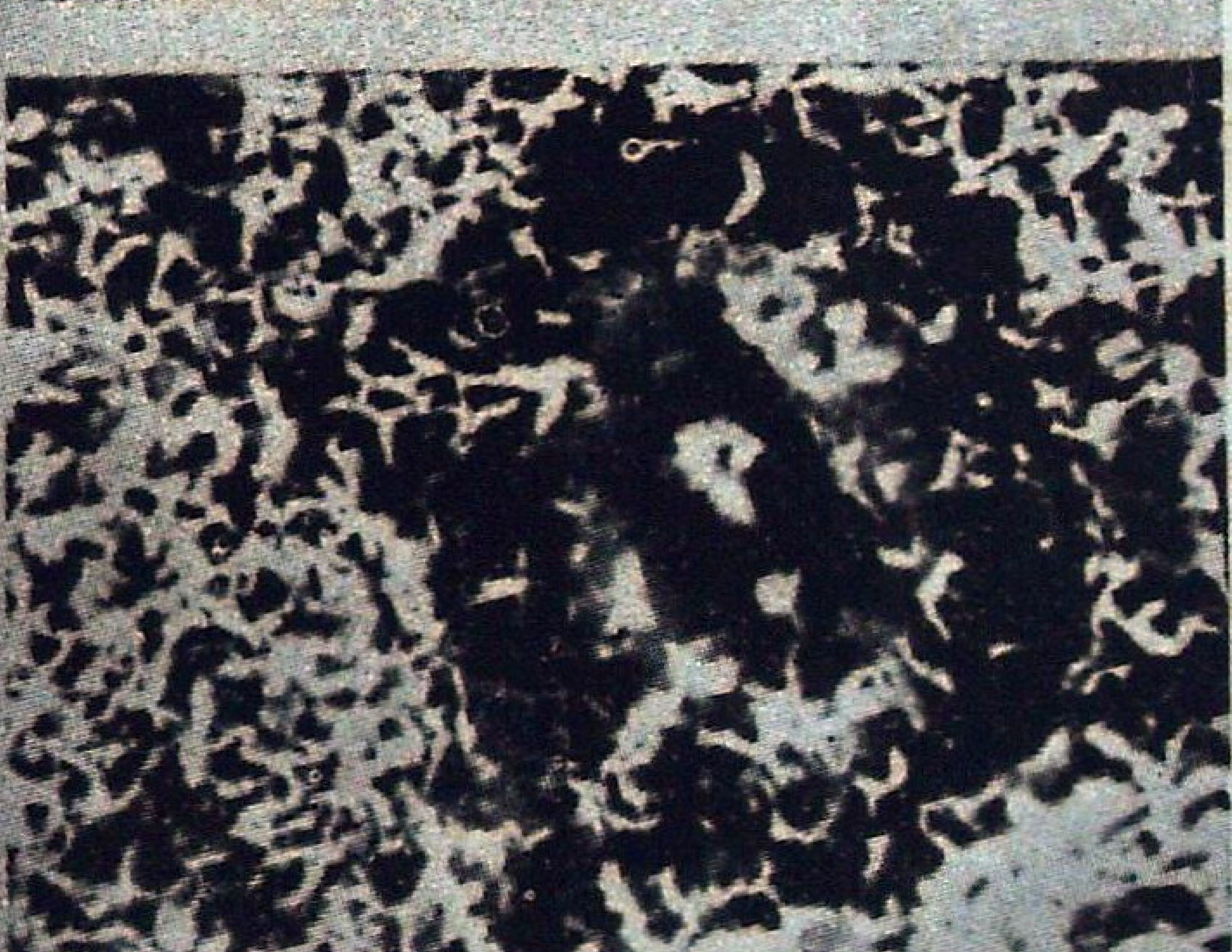
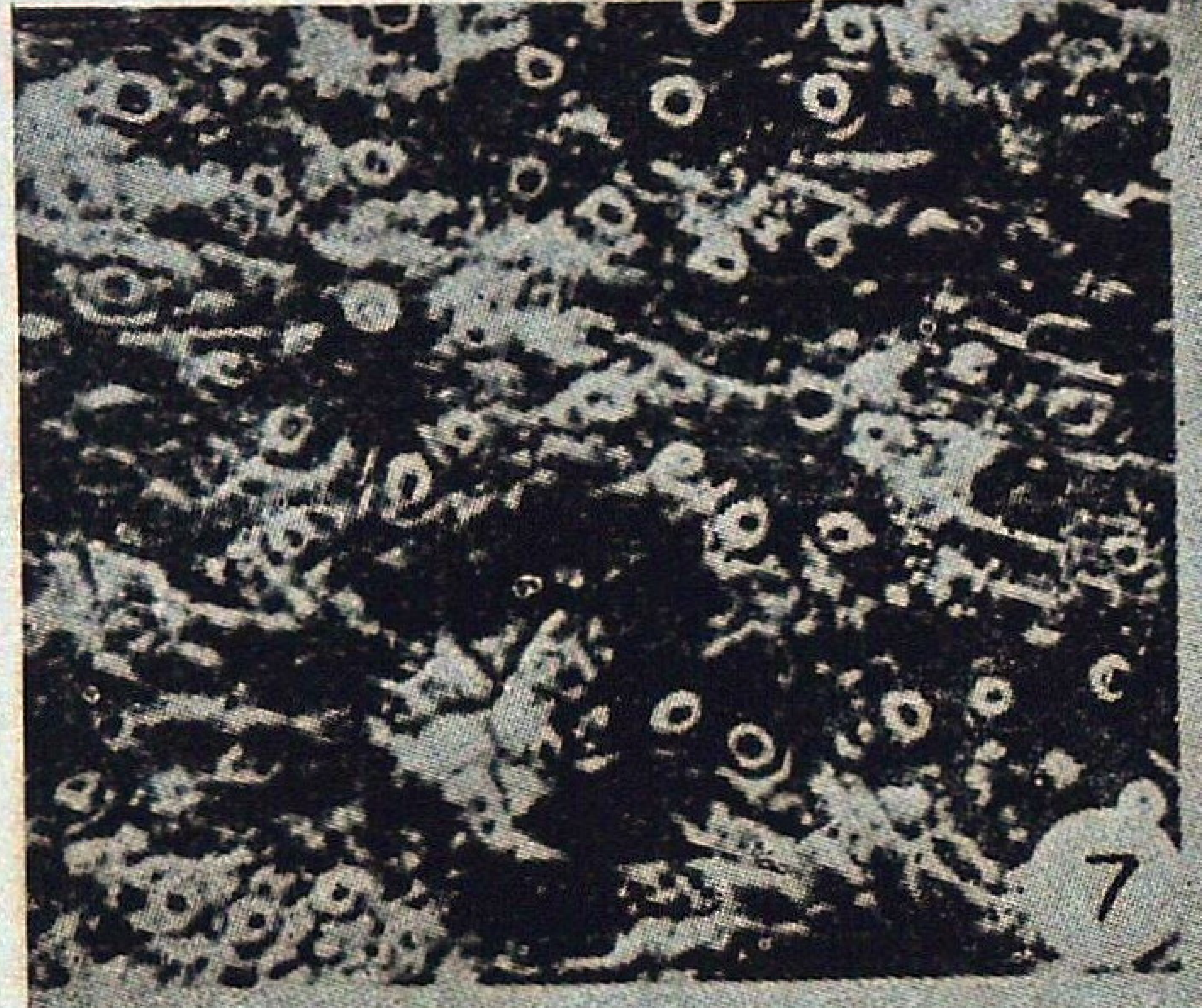
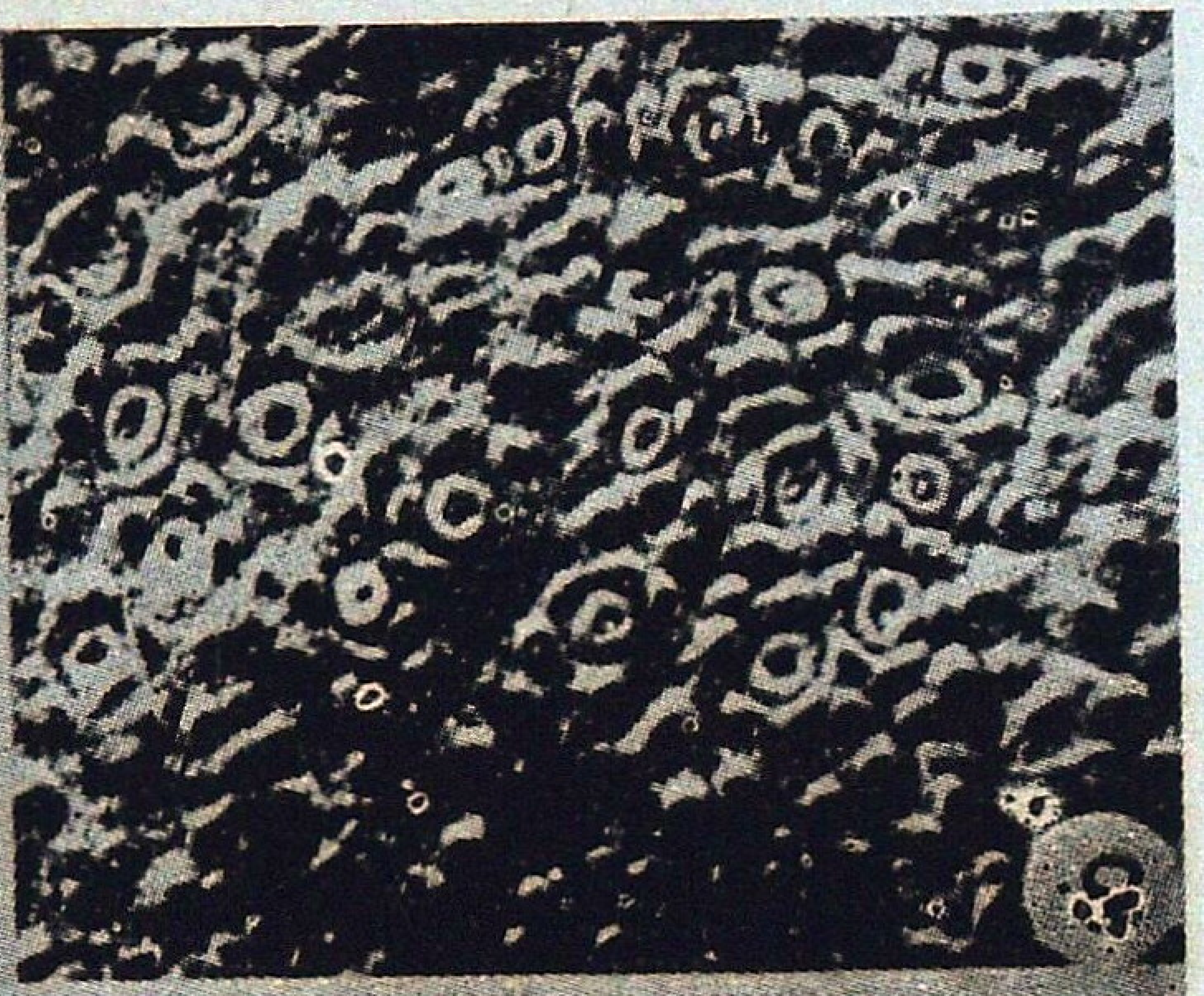


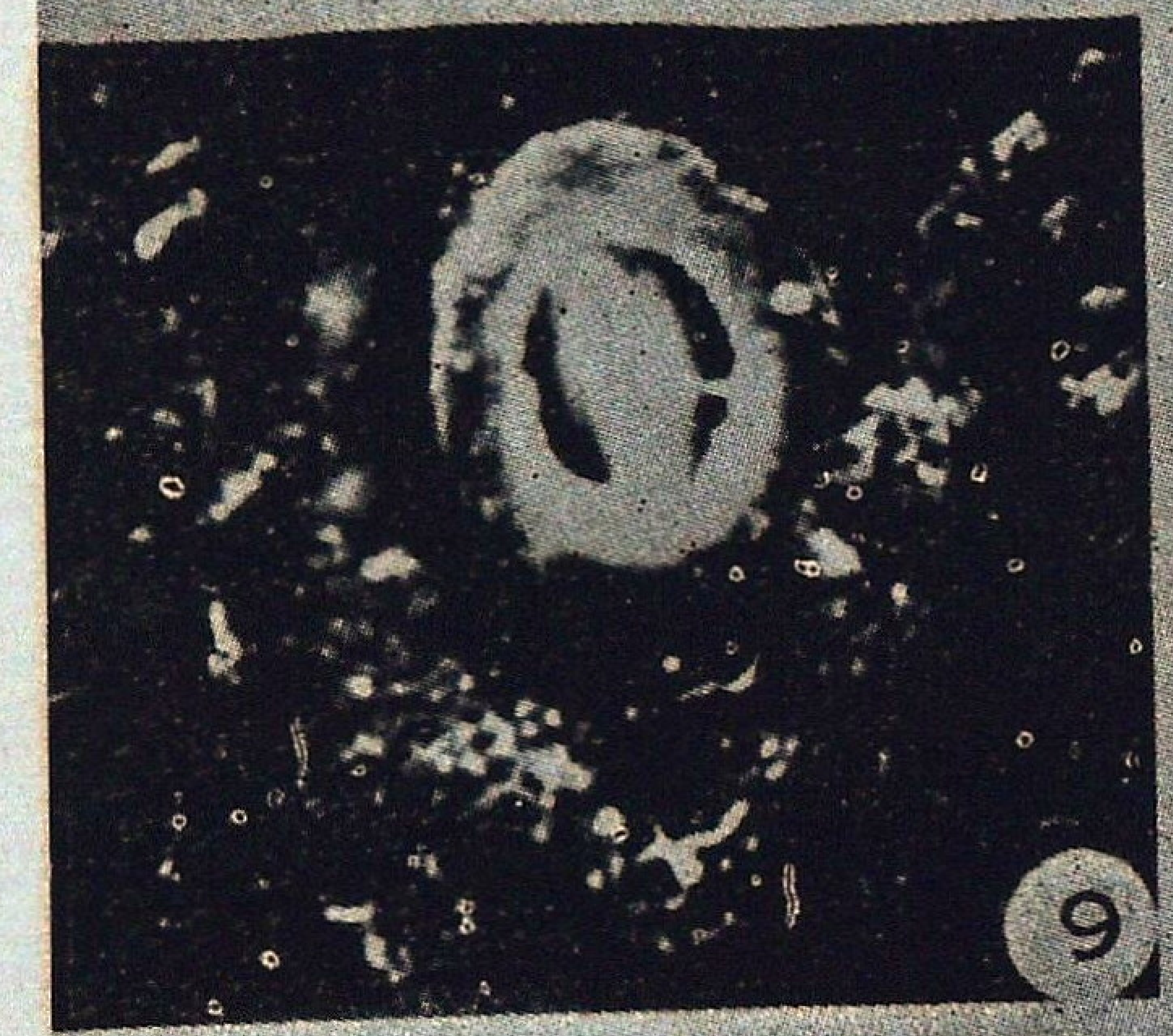
Fig. 1 —Overview of cineole-rich (>60%) leaf-X-100X

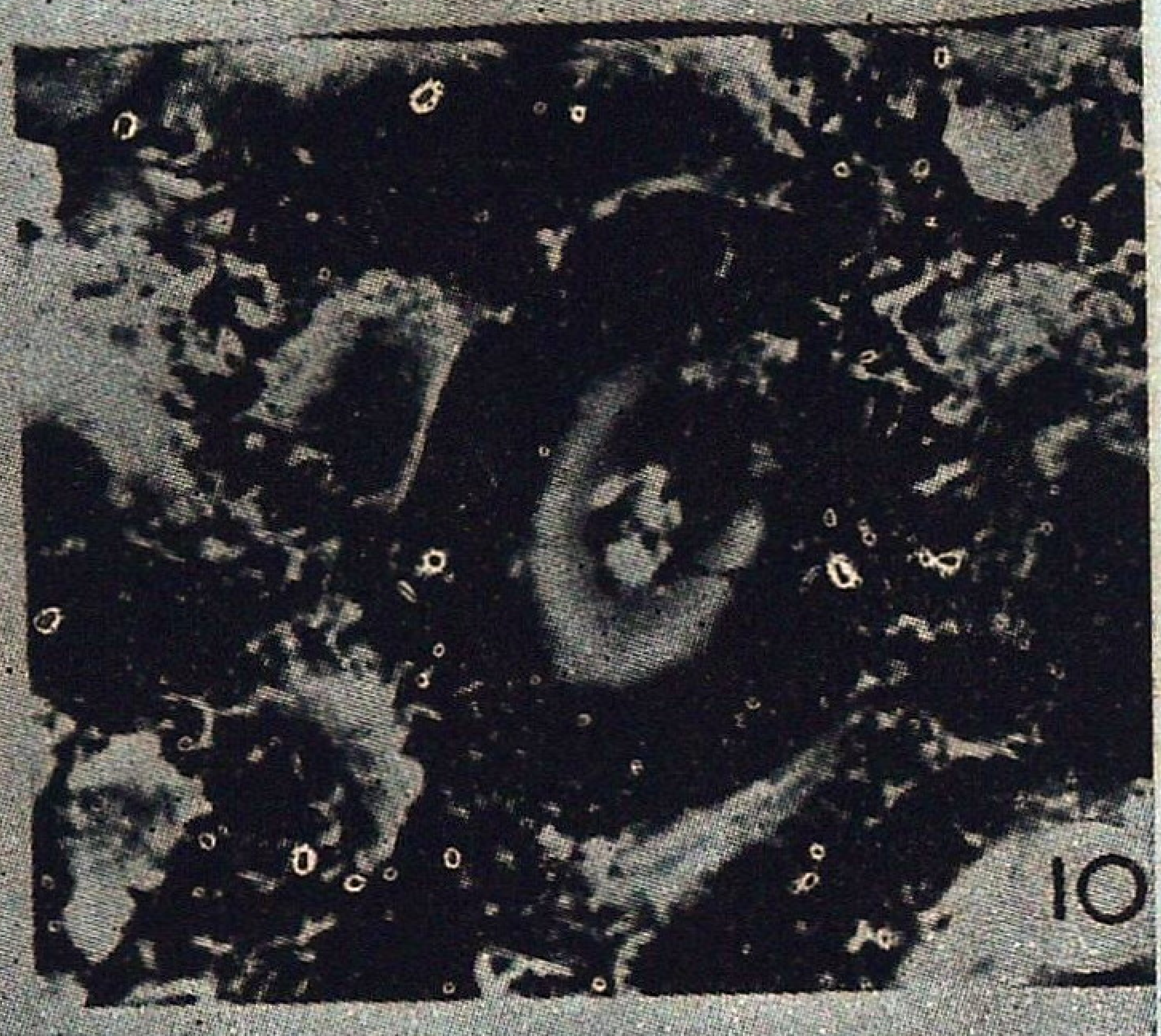
Fig. 2, 3, 4—Stomata of cineole-rich leaves showing reticulate cuticle, 200X, 1000X, 1000X

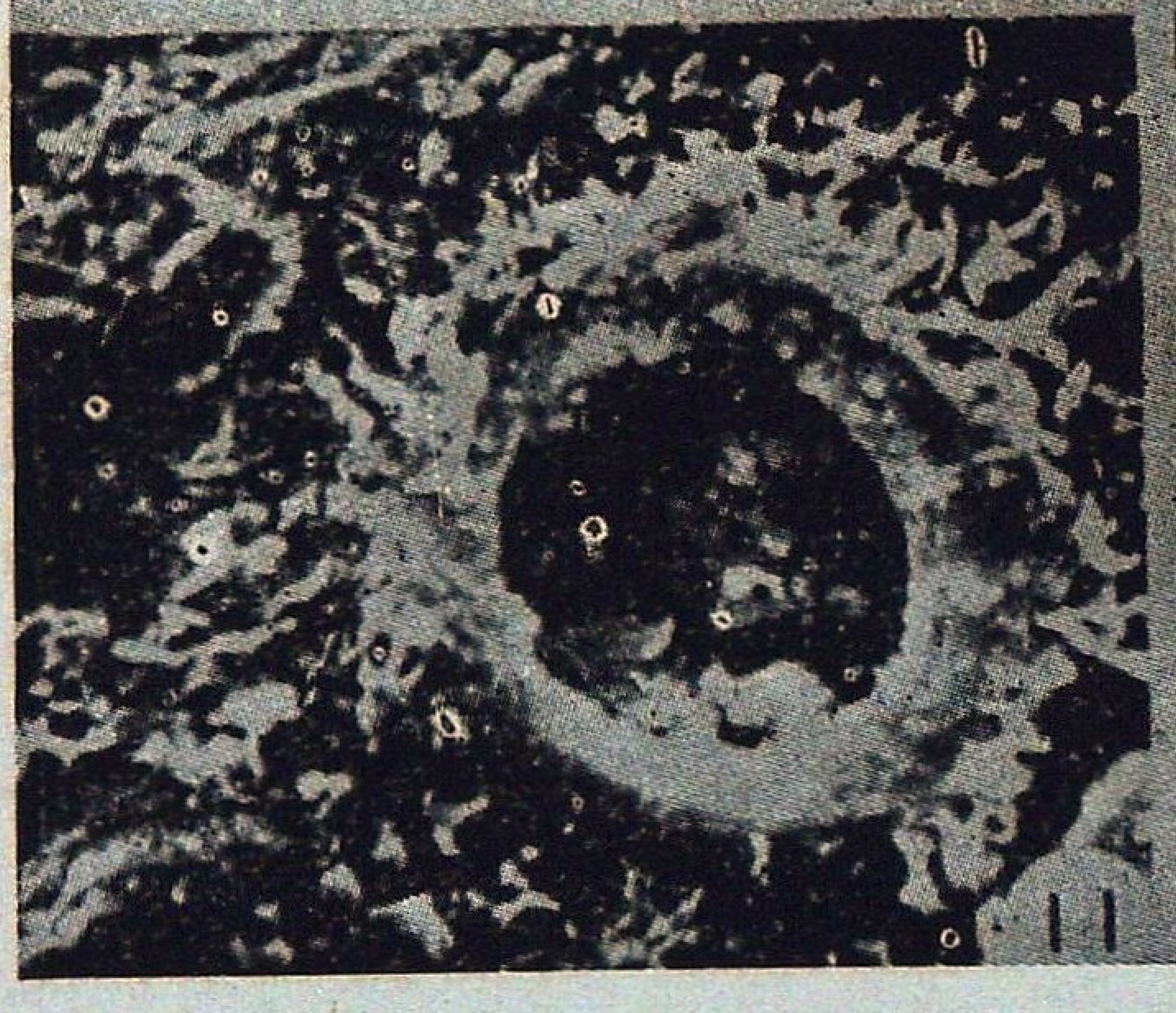
Fig. 5, 6 —Stomata of cineole-rich leaves showing, reticulate cuticle and waxy plugging 1000X











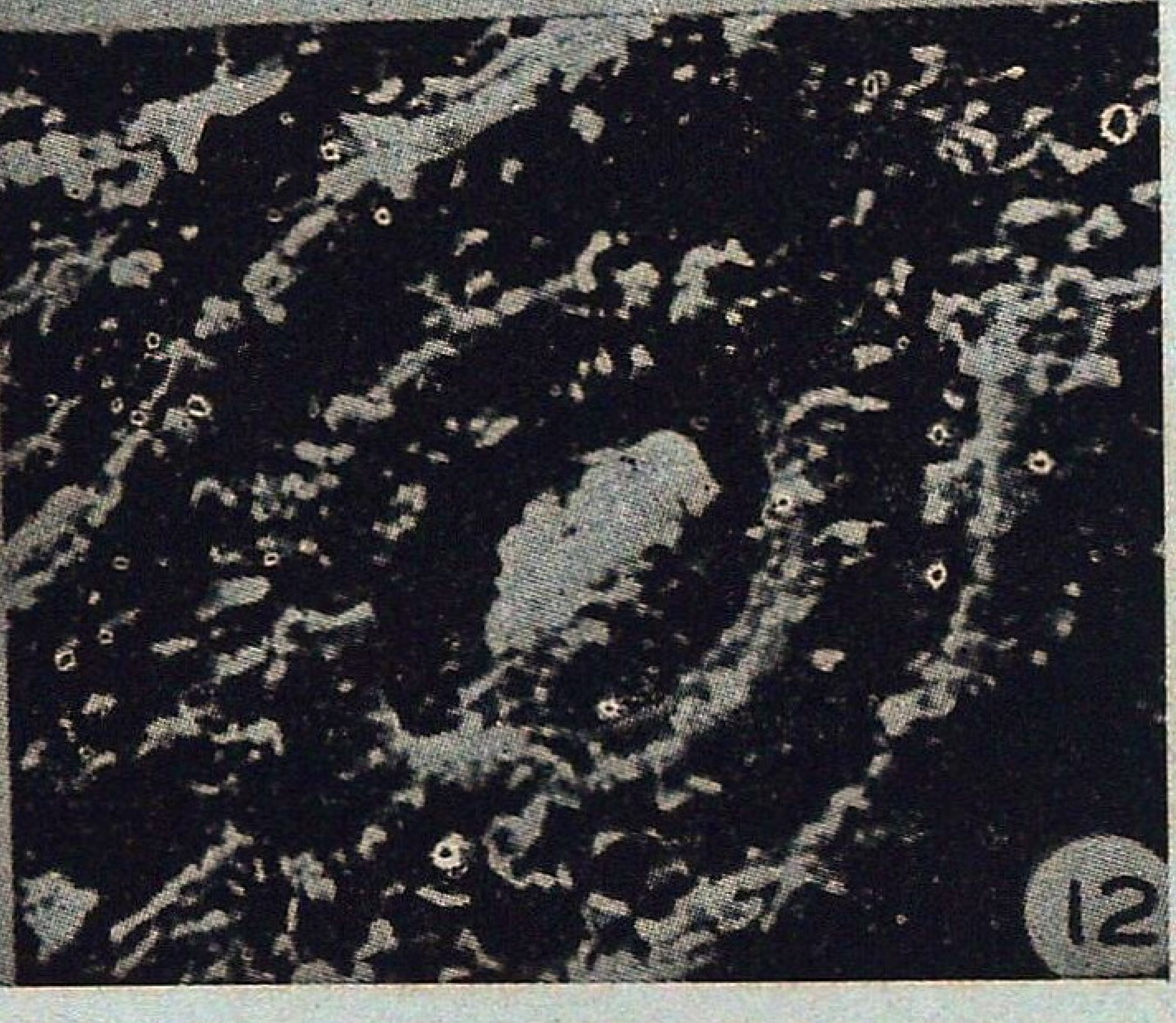


Fig. 7 —Over view of cineole-poor leaf (<60%)—100X

Fig. 8 —Over view of cineole-poor leaf (50-60%)—100X

Fig. 9 —Stomata of cineole-poor leaf (<60%)—500X

Fig. 10, 11, 12—Stomata of cineole poor leaf (50-60%) showing waxy plugging and sparce reticulate cuticle—1000X ters of the 'cineole-rich' oil yielding leaves. They have dense reticulate cuticle covering stomatal guard cells and stomatal cavity (Fig. 2, 3, 4), the latter being also plugged with wax (Fig. 5, 6). But the 'cineole-poor' oil yielding leaves have stomata, with their reticulate cuticle sometimes fully covering the guard cells. However, leaves containing oil with 50-60% cineole content have their stomata invariably plugged with wax (Fig. 10, 11, 12) and leaves containing oil with still lesser cineole content (50%) have stomatal aperture free from waxy plugging (Fig. 9).

It has been observed that cineole content of the oil in leaves increases with the decrease in the stomatal frequency per unit area, with denser reticulate cuticle. Further, wax plugging is invariably found in leaves containing oil with 50% cineole.

Conclusion

The results of SEM and LM studies show that by simply observing the average stomatal density of a leaf sample from a *Eucalyptus* hybrid tree, one can ascertain wheher the leaves are cineole-rich or cineole-poor.

Table 1

Results of comparison using 't'—Test

Between sets of observations from		Value of 't' 198 d.f.
X_1—Cineole-rich (Tree No. 5)	Cineole-poor	
	Y_1—Tree No. 3	14.39***
	Y_2— ,, 11-A	8.93***
	Y_3— ,, 4	9.43***
	Y_4— ,, J	10.17***
	Y_5— ,, Z	11.51***
	Y_6— ,, 6	11.63***
X_2—Cineole-rich (Tree No. 7)	Y_1—Tree No. 3	23 59***
	Y_2— ,, 11-A	10.47***
	Y_3— ,, 4	19.40***
	Y_4— ,, J	22.07***
	Y_5— ,, Z	24.59***
	Y_6— ,, 6	24.16***

***—Significant at 0.1% level of probability.

Table 2

Category	Mean stomatal density	95% confidence limits		99% confidence limits	
		Lower	Upper	Lower	Upper
Cineole-poor	12.67	12.17	13.17	12.00	13.34
Cineole-rich	7.72	7.22	8.22	7.05	8.30

Acknowledgements

Grateful acknowledgements are due to Dr P.K. Sen–Sarma, Director Biological Research, F.R.I. and Colleges Dehra Dun, Shri S.N. Sharma, Head of Utilisation Research, Forest Research Laboratory, Bangalore for going through the manuscript and valuable suggestions and Shri K.P. Unnikrishnan Officer–in–Charge, Statistics Branch, F.R.I. for the statistical analysis and interpretation of the data presented in this paper. Thanks are also due Shri Devindar Kumar Sharma for photographic assistance and Miss Jamuna Thapa for typing manuscript.

SUMMARY

***Eucalyptus* hybrid is grown on a large scale throughout the country mainly as pulpwood and to some extent as fuelwood. The leaves of *Eucalyptus* hybrid go to waste at present eventhrough they yield essential oil containing pinenes, cineole and other aromatic chemicals. Earlier investigations showed that some of the trees yield 'cineole–rich' oil resembling that of *E. globulus* (blue gum). As they are morphologically indistinguishable from others, a simple and rapid test based on the relationship detween refractive index and cineole content of the oil was developed to distinguish these trees from others The results of preliminary studies under light microscope supported by SEM of the epidermal features of the leaves indicate that stomatal characters such as stomatal frequency, wax plugging and raticulate cuticle can serve as useful criteria for differentiating cineole-rich ones from others. Lesser number of stomata per unit area appears to be the most important characteristic of a 'cineole-rich' leaf. This will permit screening, using equipment like LM that could be set up more easily in the field without the need of a distillation unit and its necessary heating arrangement.**

संकर युकेलिप्टस (यु० टेरेटिकार्निस) के तेल के सिनियोल तत्व और उसकी पत्तियों की मुखीय विशेषताओं के सम्बन्ध का अध्ययन

लेखक एस०एस० बिसेन, वी०वी० प्रभु व के०एस० त्यागराजन

सारांश

संकर युकेलिप्टस देश भर में सर्वत्र मुख्यत: लुगदी काष्ठ के लिये और कुछ सीमा तक इंधन काष्ठ के लिए बड़े परिमाण पर उगाया जाता है। इस समय संकर युकेलिप्टस की पत्तियां बरबाद जा रही हैं यद्यपि उनमें पाइनीन, सिनियोल और अन्य सौरभिक रसायनों वाला उत्पत तेल होता है। पहले किये गये अन्वेषणों ने दिखाया था कि कुछ वृक्षों में सिनियोल सम्पन्न तेल मिलता है जो यु० ग्लोबुलुस (ब्लू गम) से प्राप्त होने वाले तेल जैसा होता है। चूंकि रचनाकारीय आधार पर ऐसे वृक्षों को दूसरे वृक्षों से पृथक करना सम्भव नहीं है इसलिये अप्रतिचारिता निर्देशांक और तेल के सिनियोल तत्व में सम्बन्ध के आधार पर इन वृक्षों को दूसरे वृक्षों से पृथक पहचानने के लिये एक शीघ्रता से किया जा सकने वाला परीक्षण विकसित किया गया था। प्रकाश सूक्ष्मवीक्ष पर किये गये प्रारम्भिक अध्ययनों को पत्तियों की अधिस्तर विशेषताओं को सामान्य विद्युत सूक्ष्मवीक्ष द्वारा पुष्ट करने पर यह संकेत मिलता है कि पत्तियों के मुखीय लक्षण जैसे मुखों की बारंबारता, मोम से उनका बंद होना, और जालीदार उच्चर्म भी ऐसी उपयोगी कसौटियां हैं जो सिनियोल सम्पन्न वृक्षों को दूसरे वृक्षों से अलग पहचानने में काम दे सकती हैं। क्षेत्रफल की प्रतिइकाई में मुखों की संख्या कम होना सिनियोल सम्पन्न पत्ती होने का सबसे महत्वपूर्ण लक्षण प्रतीत होता है। इस प्रकार प्रकाश सूक्ष्मवीक्ष जैसा उपकरण उपयोग में लाकर ही, जिसे क्षेत्र में सरलता से स्थापित किया जा सकता है, उपयोगी वृक्षों की छांट की जा सकेगी और आसवन एकक लगाने और उसे गरम करने का आवश्यक प्रबन्ध करने की जरूरत नहीं पड़ेगी।

References

Verma, V.P.S., M.P. Shiva, R.V. Subramaniyam and R.K. Suri (1978) *Indian For.* **104**, 846–850.

Theagarajan, K.S. and P.S. Rao (1970). *Indian For.* **96**, 347–50.

Theagarajan, K.S., V.V. Prabhu, M. Subramani and A.K. Ananthanarayana (1944). *Curr. Sci.* **46**, 733–735.

Theagarajan, K.S. and V.V. Prabhu (1981). *Jour. Indian Acad. Wood Sci.*, **12**, 55–57.

A NOTE ON PRODUCTION OF HIGH ALPHA CELLULOSE PULP FROM *LEUCAENA LEUCOCEPHALA*

Y.K. SHARMA, SUSHMA MAHAJAN AND P.P. BHOLA

Cellulose and Paper Branch,
Forest Research Institute and Colleges, Dehra Dun (India)

Introduction

Leucaena leucocephala (Su-babul) is a fast growing raw material for pulp and paper industry. The tree is indigenous to Central America but has shown great promise in India. It is a fast growing species and provides large quantities of firewood and foddder in a very short time. Besides this it has the capacity of enriching the soil through nitrogen fixing bacteria.

In an earlier investigation carried out by Bhola and Sharma (1982) the results of proximate chemical analysis, fibre dimensions and chemical pulping for the manufacture of writing and printing paper have been described.

The present investigation was carried out to determine the suitability of *L. leucocephala* for the production of dissolving pulp for rayon manufacture by water prehydrolysis sulphate process followed by the multistage bleaching.

Experimental

Leucaena leucocephala K 8 variety was received from Silviculturist, Sal Region, U.P. in the form of logs having average diameter of about 12 cm. The bark was removed manually. The chips were screened on a waterous vibratory screen. The material passing through a 44 mm^2 mesh and retained on 6.5 mm^2 mesh was collected and taken for the preparation of rayon grade pulp.

The screened chips were processed by the water prehydrolysis sulphate process followed by multistage bleaching. The optimum conditions of water hydrolysis, pulping and bleaching are given below :

Water Prehydrolysis

Material : Liquor ratio : 1 : 4
Cooking temperature, °C : 162
Cooking time, hrs. : 3 (1½ hrs to raise the temp. to max.)
pH of spent liquor : 4.2

Sulphate Digestion

Total Chemicals as Na_2O, % : 20
Sulphidity, % : 25
Bath ratio : 1 : 3 : 5
Temperature, °C : 1.70
Time, hrs. : 3 (including 1½ hrs to raise the temp. to max.)
Unbleached Yield, % : 43.7
Kappa No. : 17.0

Table 1

Comparision of Dissolving Pulps from Different Raw Materials with Leucaena leucocephala

Sl. No.	Analysis	*Leucaena leucocephala*	*Dendroclamus strictus*	*Arundo donex*	*Eucalyptus grandis*
1.	Yield of bleached pulp, %	39.8	26.0	24.1	32.8
2.	Alpha cellulose, %	92.2	90.1	92.4	94.5
3.	Beta cellulose, %	6.2	8.1	5.5	4.3
4.	Gamma celloulose, %	0.3	1.8	1.7	3.3
5.	Ash, %	0.013	0.07	0.11	0.10
6.	Brightness	82*	84**	82**	86**

* Elrepho Brightness (% ISO)
** %GE

Table 2

Specifications for Viscose Rayon Grade Pulp (Ott, *et al*, 1954)

Sl. No.		Cellophane	Textile	Tyre cord
1.	Alpha cellulose, %	87–91	89–92	94–96
2.	Beta cellulose, %	5–7	3–5	2–3
3.	Gamma cellulose, %	3.5	3.6	1.5–3.5
4.	Ash, %	0.05–0.13	0.04–0.13	0.04–0.08

Bleaching of the Pulp

The water prehydrolysed sulphate pulp was bleached by multistage bleaching by C/E/H/E/D/SO_2 sequence as given below.

First Stage (Chlorination)

Available Chlorine on o.d. pulp, % : 2.0
Consistency, % : 3
Temperature, °C : 20
Time, minute : 30

Second Stage (Caustic Extraction)

Caustic Soda, % : 2
Consistency, % : 5
Temperature, °C : 50
Time, minute : 60

Third Stage (Sodium Hypochlorite)

Available Chlorine on o.d. pulp, % : 1.50
Consistency, % : 6
Temperature, °C : 50
Time, minute : 90

Fourth Stage (Caustic Extraction)

Conditions same as in Second Stage.

Fifth Stage (Chlorine Dioxide)

Avialable Chlorine on o.d. pulp, % : 1.50
Consistency, % : 8
Temperature, °C : 80
Time, minute : 90

Sixth Stage

Washing with Sulphure dioxide solution in water.

Results and discussion

The analysis of bleached pulp was carried out by standard procedures and is given in Table 1. The results have been compared with ***Dendrocalamus strictus*** (Karnik, 1961) ***Arundo donax*** and ***Eucalyptus grandis*** (Guha ***et al***, 1963). Specifications (Ott ***et al***, 1954) for Viscose Rayon Grade Pulps for different end uses have been given in Table 2.

The chemical analysis of ***Leucaena leucocephala*** (Su-babul) pulp indicates that the raw material is suitable for the production of Cellophane and continous filament (Textile) in a high yield (39.8%) by water prehydrolysis sulphate process followed by multistage bleaching.

SUMMARY

The present investigation reveals that the Su-babul can be utilised for the production of alpha-cellulose. The chemical purity shows that the raw material is suitable for preparing cellophane and textile in high yield (39.8%).

ल्यूसेना ल्यूकोकेफाला से उच्च एल्फा कोशाधु लुगदी बनाने पर एक टिप्पणी

लेखक वाई०के० शर्मा, सुषमा महाजन व पी०पी० भोला

सारांश

प्रस्तुत अन्वेषण से पता चलता है कि सुबबूल को एल्फा कोशाधु तैयार करने के लिए उपयोग किया जा सकता है। रासायनिक शुद्धता ने दिखाया है कि यह कच्चा माल अधिक प्राप्ति में (39.8%) सेलाफेन और वस्त्र बनाने में उपयोगी है।

References

Karnik, M.G. (1961), Viscose Rayon Grade Pulps from Bamboo (***Dendrocalamus strictus***) by water prehydrolysis sulphate process. ***Indian Pulp and Paper*, 15** (11) : 655.

Bhola, P.P. and Y.K. Sharma (1982). Kraft pulping of ***Leucaena leucocephala*, *Indian For*. 108** (3) : 202.

Guha, S.R.D. and Man Mohan Singh (1963). Production of high alpha cellulose pulp from *Arundo donax*., *Indian Pulp & Paper*, **18** (3) : 63.

Ott, E , H.M. Spurlin and M.W. Grafflin (1954). "Specifications for Viscose Rayon Grade Pulp; *Cellulose* Part II, 964.

CROP VOLUME AND OUT-TURN TABLE FOR STANDS OF *ACACIA NILOTICA*

H. RAJAGOPAL SHETTY

Deputy Conservator of Forests,
Mettur Soil Conservation Scheme, Salem (*Tamil Nadu*)

Importance and Extent

Plantations of *Acacia nilotica* (Hindi : Babul; Tamil : Karuvel; Kannada: Jali; Telugu : Nalla thumma) were raised in Tamil Nadu from the year 1960-61 under the scheme "Farm Forestry" with the object of meeting fuel, small timber and fodder requirements of the villages. These plantations were raised within the village limits outside reserved forests, mostly in tank beds so as to stall the ever increasing demand and depletion of trees in reserved forests. Encouraged by the success, similar work has been carried out in recent years under various other schemes such as "Village Forests", "Extension Forests" and "Drought Prone Area Programme" etc. Over 1,60,000 ha are under Babul at present in Tamil Nadu alone. At the current tempo of afforestation works under SIDA aided Social Forestry Scheme, it is estimated that a total of 4.5 lakhs ha will be under Babul plantations before 91-92. No other trees species has been raised artificially in pure crop so extensively in afforestation works outside reserved forests anywhere in India as Babul.

Earlier plantations have already been harvested and more areas will be due for harvest in the future years. Before 1985 over, 10,000 ha are expected to be available for harvest annually with a promise of nearly 3 lakh tonnes of wood and three crore Rupees of annual revenue. According to present trend, the area available for harvest will rise to 40,000 ha annually with a yield of 12 lakh tonnes of wood and Rs. 15 crores of revenue before the turn of the century. Species-wise it is the chief fuel wood in use at present both in urban and rural areas in sevral districts of the state, with the exception of only *Casuarina* in coastal areas.

The need for Crop Volume Table :

The babul plantations with its multiple uses are destined to play an important role in the field of agriculture and as fodder, as a source of energy as fuel wood, and also as an important raw material for several industries. There is an urgent need for a crop volume table and also an out-turn table in assessing the yield for planning and for fixing the fair price before sale.

Distribution of Sample plots :

Data collected in 62 sample plots were utilised for computing. The sample plots are distributed as follows to represent all regions and all forms of growth within the state

Salem Circle	...	35
Trichy Circle	...	13
Maburai Circle	...	9
Coimbatore Circle	...	5
		62

Nature of Crop :

(a) Sample plots were laid in plantations which are under felling. All these plantations were 10 years in age or a little above, upto 13 years in a few cases.

(b) These plantations were raised mostly at an espacement of 9′ × 9′ and 11′ × 11′ in the earlier years and later at an espacement of 2½ m × 2½ m; 3 m × 3 m and 3½ m × 3½ m.

(c) Quality of crop showed high variation even within a small areas. The height of the crop varied from as low as 2 m to 13 m, presenting a fertility gradient, which decisively dipped in upper parts of the lake with poorer silt and moisture conditions, often with shallow, and gravelly soil or alkaline patches. The crop was usually luxuriant in lower reaches of lake with better silt and moisture.

(d) The condition of protection of the crop was also varying. Specially the plantations close to the villages suffered loss of side branches, upto considerable height. Since basal area and height of the crop is not affected by the loss of the side branches but affected the yield upto 33%, this has been a major cause for deviations in yield from norm when the results were computed. However, this has to be accepted as inevitable variation, since there is no way either to control it effectively or to quantify it precisely.

Classification, definition and uses of produce :

Out-turn from Babul trees can be classified as follows :

(i) *Fuelwood* : It consists of
   (a) Billets and
   (b) Faggot wood

(a) ***Billets*** : Billets are wood down to 5 cm diam (O.B.) cut to one metre length, and is generally used as fuelwood by bulk consumers. This wood goes by the name 'Varagu', 'Kattai', 'Kattai Varagu', 'size' etc. locally.

(b) ***Faggot wood*** : This is also a fuelwood. Wood less than 5 cm diam (O.B.) and down to 2 cm diam (O.B.) is included in this class. This type of wood is usually cut to about 70 cm long pieces convenience of storing by domestic consumers. This class of wood is variously called as 'Kutchi', 'Kutchi Varagu', 'Sulli', 'Kaikutchi' etc. and is sold in bulk or in 'Gundu' (25 kg) when sold in small quantity.

Industrial Pulpwood :

This is debarked wood down to 5 cm diam (O.B.). It is measured usually in tonnes of air-dry material. The wood has proved to be an excellent raw material for paper and rayon.

Bark :

Bark of babul is rich in tannin and used in tanning industry. It contains about 12% of tannin and gives good finish to leather specially when blended with chebula fruits. The yield of bark during conversion of billets to pulpwood is about 22% on the average. Bark is also used in the fermentation in the manufacture of country liquor. Air-dry bark is chipped or powdered and filled in gunny bags and sold in tonnes for use as tannin material.

Brushwood :

(a) These are the top ends of the trees, containing twigs about 2 cm diam (O.B.) and below. It is variously known as 'Milaru', 'Mandi', 'Sikkalu', Maru, etc. locally.

(b) When trees are low or young, the brush wood is full of spines. However, when the tree grows tall, above the reach of cattle, it is almost unarmed. The cattle, including goats, and sheep, feed on this with great relish.

(c) This material is used for fencing, as a fuel by poorer section, and in the brick kilns for kindling fire. It is sold in head loads of about 15 kg in the villages.

Analysis

The data collected was analysed in IBM 1620 computer at the Computer Centre, College of Engineering, Guindy, Madras. Various regression equations were tried for linear, curvilinear, and exponential curves and the best fit was adopted.

The following abreviations are used :

V (F) : Volume of fuelwood.
V (P) : Velume of pulpwood.
V (B) : Volume of Bark.
V (Fg) : Volume of Faggot wood.
Wt. (B.W) : Weight of Brush wood.
Ba : Basal area in m^2 per ha.
H : Crop height in metres.

Fuelwood :

The estimating equations got from the power fit of following form is found to be the most suitable and hence adopted.

$$V(F) = 0.99675717\ (Ba.H) \uparrow 0.90522849$$

Where V (F) is the yield of fuelwood in m^3 ha.

The standard error and correlation coefficient are as follows :

S.R. = 5.4500

Correlation coefficients : 0.9876

Pulpwood : A linear fit of the following form is found to be superior to other forms tried :

$$V(P) = -1.7030804 + 0.39414203\ (Ba.H.)$$

Where V (P) is the out-turn of pulpwood in m^3 per ha. The result of analysis of variance is as follows :

Source of variation	Degree of freedom	Sum of squares	Variance	Variation ratio (F)		Determination coefficient (r^2)
				Observed	Expected	
Linear	1	30358.9	30358.9	58.3661	7.08	.956826
Due to residual.	61	31728.8	520.1	45		
Total	62	62087.7	30879.0			

This is found to be significant at 1% level of probability. The standard error and correlation coefficient are as follows :

S.E. = 4.710847

Correlation coefficient : (r) : .9782

Bark : Linear regression of the following form is found to be the most suitable :

V (B) θ .25125984 + .10574571 (Ba. H) where V (B) is the estimate of valuable bark upto pulpwood limit. The analysis of variance is as follows :

Source of variance	Degree of freedom	Sum of squares	Variance	Variance ration (F)		Determination coefficient (r^2)
				Observed	Expected	
Linear	1	2185.27	2185.27	58.4073	7.08	.957498
Residual	61	2282.27	37.41			
Total	62	4467.54	2222.68			

This was found to be significant at 1% level of probability.

The standard error and correlation coefficient are as follows :

S.E. = 1.26102

Correlation coefficient = .9785

Faggot wood :

A power curve fit of the following form is found to be the most suitable.

V (Fg) = 0.77535648 (Ba.H) ↑ 0.66389827 where V (Fg) is the out-turn of faggot wood in m^3 per ha.

The standard error and the correlation coefficient are as follows :

S.E. = 3.969529

Correlation Coefficient = .8562

Brushwood :

Power curve of the following form is found to give the most satisfactory results.

Wt. (BW) = 0.7956341 (Ba.H) ↑ 0.57858673

Where Wt. (BW) is the weight of air-dry brushwood in tonnes per ha.

The standard error and the correlation coefficient are as follows :

S.E. = 3.46996

Correlation coefficient) = .7357

Relationship of Crop height to top height and average height :

In sample plots of less than .1 ha close relationship was observed between crop height, top height and average height of the sampled crop, even though the crop is usually variable within the plantation limits.

When a linear fit was tried for the relationship between top height (TH) and crop height (CH) the estimating equation was of the following form :

(T.H.) = .44037991 + .98487119 (CH)

The standard error and correlation coefficient are as follows:

S.E. = .0787599

Correlation coefficient = .9939

As it is easier to determine top height in small sample plots and it will save time in the collection of field data, a correlation table between crop height and top height is fitted to the various tables appended for convenience of reference.

The tables for yield of fuelwood and out-turn of pulpwood, Bark, Faggot-wood and Brushwood are appended.

Acknowledgements

I am indicated to Dr. T.R. Natesan, Professor of Electrical Engineering, Computer Centre, Engineering College, Guindy, Madras and his associates for their invaluable help in processing the data.

I record my gratitute to Shri K.R. Venkatesan, I.F.S., Tamil Nadu Cadre, Shri G.C. Pande, I.F.S., Uttar Pradesh Cadre and Shri K. Venkatakrishan; I.F.S., (Retd.) Tamil Nadu Cadre, for their guidance and encouragement in the successful completion of the project.

SUMMARY

Babul plantations occupy by far the largest area among the tree crops raised artificially in Tamil Nadu. More areas are brought under this crop annually under Social Forestry all over in the South. Use of Babul wood as fuel, timber and in agriculture is well known. It can also be used for pulp in paper and rayon industries and the bark, for tanning. A crop volume and out-turn table is essential for the proper management of this growing asset. Out-turn table for fuelwood, pulpwood, bark, faggot-wood and brushwood is furnished separately, against independent variables of basal area and height.

अकेसिया नीलोटिका वनों की सस्य आयतन और प्राप्ति सारणियां

लेखक एच० राजगोपाल शेट्टि

सारांश

तमिलनाडु में कृत्रिम रूप से उगाए जा रहे वृक्ष सस्यों में सबसे अधिक क्षेत्रफल बबूल के रोपवनों ने ही घेरा हुआ है। सामाजिक वानिकी के अन्तर्गत समूचे दक्षिण भारत में प्रतिवर्ष अधिकाधिक क्षेत्रफल इसके अधीन लाया जा रहा है। ईंधन, प्रकाष्ठ और कृषि में बबूल की लकड़ी का उपयोग होना सभी को पता है। इसे कागज और रेयन उद्योगों में भी उपयोग किया जा सकता है तथा इसकी छाल चर्म संस्कार के लिये। इस वर्धमान परिसम्पत्ति के लिये सस्य आयतन और प्राप्ति सारणी बनाना बहुत जरूरी है। आधारिक क्षेत्रफल और ऊंचाई के स्वतन्त्र विचरों द्वारा ईंधनकाष्ठ, लुगदीकाष्ठ, छाल, गट्ठाकाष्ठ और झाड़ीकाष्ठ की अलग-अलग प्राप्ति सारणियाँ तैयार की गई है।

References

Chaturvedi. A.N. and K.G. Venkatraman (1973). Volume and Weight table for *Eucalyptus* hybrid : *Indian For*. **99** (10) : 599-608.

GUJARAT EXPERIENCE OF *EUCALYPTUS*

G.A. PATEL

Conservator of Forests, Monitoring.
(C.F.P.), Vadodara (Gujarat)

Introduction

Gujarat State is one of the forest poor States having hardly 10% of its total area under forest cover. The productive area in fact is only half as much. The State owned forests yield about 0.16 m metric tonnes of fuelwood and 1.3 lacs m^3 of timber whereas the consumption of fuelwood and timber in the State is estimated at 6.07 m metric tonnes and 8.6 lacs m^3 respectively. The forests are therefore, not in a position to fully meet with the demands of the population as regards constructional timber, small timber and firewood. Consequently, price of forest products have soared very high in last one decade. Due to severe scarcity of fuelwood especially in the rural areas, the people and especially the farmers are forced to burn cow dung and agriculture waste for cooking and heating purposes. These organic ingredients are very necessary to keep the soil structure in porous and healthy condition increasing its capacity to absorb rain water. Consequently increase its fertility. It has been estimated that a tonne of cow dung applied to the soil could raise its productivity and yield by an additional 560 kg of food. Besides this, trees create a very effective anti-erosion measure to save top soil from being blown away by wind or washed away by rains. Though farmers are aware of these facts, they are helpless as alternative cheap energy is not available for their use. Marginal and small farmers and landless labourers who constitute a major portion of the village population, whose income is so low that they cannot buy firewood and at the same time have no easy access to agriculture waste are required to spend some time in search of fuelwood. This has adversely affected the development of poor people in many ways such as wastage of manpower, depriving the children of education and keeping them economically backward. Because of non-availability of firewood and small timber some time they cut fruit trees whatever available with them in the fields village. To overcome shortage of small timber, fuelwood, etc. the Gujarat Forest Department launched a Social Forestry Programme a decade age raising plantations in non-traditional areas such as road and canal railway sides, gaucher lands, etc, This was, however, not sufficient. The biggest resource lay in more than 35 lacs of farmers in the State. With a view to make individual farmers not only self-sufficient in their requirements of small timber and fuelwood but surplus, the department motivated farmers to grow

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A paper presented at the Workshop on Socio-Economic Aspects of Eucalyptus plantations, organised by the Planning Commission at New Delhi on 21st May, 1984.

trees singly, in groups or on border of their fields and supplied free seedlings and technical know how. In the year 1971, one leading and on lightened farmer was induced to raise *Eucalyptus* in his farm. Fully convinced about more profitable returns from tree farming he, within a period of three years, planted *Eucalyptus* successfully, in 75 ha of this land and this become a modal for others. By now, more than 2,63,000 farmers have raised trees in their farms. Details are as under :

Table 1

Distribution of Seedling to farmers by size of land holding

Size of land holding (ha)	No. of seedlings distributed upto 1983-84 (m)		Area planted (ha)		No. of farmers who have done tree planting upto 1983-84	
0.1 to 2.00 (Marginal)	146.14	43%	30291	41%	176892	67%
2.1 to 4.00 (Small)	110.70	33%	22676	31%	52871	20%
Over 4 ha Big	81.80	24%	20201	28%	33349	13%
Total :	338.64	100%	73118	100%	263112	100%

Out of the total seedlings planted in Gujarat more than 80% seedlings are of *Eucalyptus tereticornis* commonly known as *Eucalyptus* hybrid.

Now a days there is a criticism from various quarters that valuable farm lands are being diverted from agriculture to forestry crops, particularly from grain crops to tree crops and that bigger farmers are taking the advantage of free supply of seedlings. Even a few important personalities whose voice contributes to the making of Government policies have made some adverse comments.

As a department, we are interested in seeing that more and more trees are planted, reared and protected not only for improving the ecological balance and environmental stability but also for meeting the basic needs of our people in respect of fuelwood, small timber, fodder, etc. At the same time, we are also aware that forest crops should not replace the food crops on good fertile land. We have been trying in this direction and persuading people to raise trees either along the boundary of their agriculture lands or by way of shelter belts as this methodology is beneficial to both agriculture land and food production. Earlier we have not collected any authentic data to show whether criticism made above both in press and vocally has any substance in it or it is baseless. To know the correct position about 8000 farmers are selected from 19 districts (whole state) who have taken up tree plantation on their farms by random selection method for survey purpose by the monitoring cell. Out of 8000 farmers elected for this purpose till last month, 1920 farmers were interviewed and their plots were visited by the staff for collection of data. The available data was analysed. Details are as under :

Table 2

Type of farmers who have undertaken tree planting on their agriculture land
(Out of sample of 1920 farmers).

Category of farmers	No. of farmers	Percentage of Total
Marginal	737	38.40%
Small	198	25.90%
Big	585	35.70%
	1920	

This analysis shows that about 65% farmers are from small and marginal groups. It is true that initially advantage of free distribution of seedlings was taken by big farmers. However, it is known to every one that wherever any change from traditional method is to take place, it is the big farmer who takes risk and sets the example for others as it is beyond the capacity of small and marginal farmers to put their bread at the stake and starve. In Gujarat, demand for *Eucalyptus* seedlings by small and marginal farmers has subsequently increased tremendously. Last year in Vyara taluka of Surat District, 4500 Tribal farmers have planted 92,00,000 seedlings. Similarly, in Chhotaudepur taluka, 2000 tribal farmers and in Dharampur Taluka, 1600 farmers have planted 40 lakhs and 30 lakhs seedlings respectively. Plantation of *Eucalyptus* is done mostly on boundaries of the field, fellow land and area which was not suitable for agriculture crop.

Table 3

Sites where tree planting is done by formers

	No. of farmers.	
(a) Along the irrigation channel	28	1.5%
(b) On the periphery (Farm boundaries)	1070	55.7%
(c) Block planting	822	42.8%
	1920	

Table 4

Before taking up tree planting what was grown by the farmers

(a) Fallow land	1210	63%
(b) Cash crop	269	14%
(c) Food grain	123	6.4%
(d) Mixed Crop	318	16.6%
	1920	

This shows that plantation is mostly done on field boundaries by the farmers and negligible number of farmers who were growing food grains have taken up farm forestry in good fertile lands.

Table 5

What was grown on the area where tree farming is taken up.

(Sample area 971 ha).

(a) Fallow land	385 ha	39.65%
(b) Cash Crop	261 ha	26.88%
(c) Food grain	71 ha	7.31%
(d) Mixed crop	254 ha	26.16%

In Gujarat, so far about 72,000 ha area is covered under farm forestry which is less than 1% of total agriculture land. Out of the total area under farm forestry only 5000 ha area where earlier food grains were grown have come under tree plantation which is 0.05% of total agriculture land. This clearly shows that whatever the criticism made against farm forestry is without any base and will ultimately have adverse effect on the successful programme of meeting the fuelwood and small timber demands of the weaker sections of the society.

It is true that farmers have taken up *Eucalyptus* plantation only because of monetary gains. But studies have shown that in Gujarat by and large only poor lands where agriculture is becoming uneconomic are diverted to *Eucalyptus* planting. There are, however, a few exceptions. To stop *Eucalyptus* and plant local spp. which do not give equal economic returns is like forcing them to plant wheat against cash crop. Farmers in Gujarat mostly grow what is more profitable to them which has also been supported by the findings of this study. Details are as under :

Table 6

Reasons for taking up Farm forestry

Sr. No.	Reason	No. of farmers	Percentage
1.	Agriculture is becoming uneconomical & risky	662	34.5%
2.	Tree farming is more profitable than agriculture	982	51.1%
3.	Due to shortage of labour	182	9.5%
4.	Other reasons	94	4.9%
	Total :	1920	100.0%

This analysis clearly shows that agriculture is becoming uneconomical and risky due to the uncertainty of rains, scanty irrigation facilities and requirement of heavy inputs like fertilizers and insecticides particularly in case of cash crops in Gujarat. At the same time, tree farming has because more profitable compared to agriculture in inferior or fallow lands and particularly against cash crop.

By this way, if more trees are grown, Government should support them as we need more trees. Particularly when national forestry policy envisages that 60% area in hills and 20% area in plains should be under trees, this is the only way to increase the tree cover as it is not possible to get more area under forest when there is acute land hunger for agriculture.

The Government of Gujarat has formulated the scheme to help small and marginal farmers to grow trees, leaving the choice of specific trees to the farmers to make them self sufficient in their demand of firewood and small timber. Many examples are there where marginal and small farmers who have undertaken tree farming alongwith agriculture crops before 4 years are now in a better financial position than earlier. One harijan farmer in Baroda district who was in debt had planted 1200 *Eucalyptus* trees along the boundaries of his field in 1979-80. He had taken the loan from bank for improving his land, which he was not able to repay. In 1983, he had cut and sold 700 *Eucalyptus* trees which he had planted on the boundaries of his field and was able to pay back the loan and at the same time some money was available for his own use. There are so many such examples in Gujarat where farmers economical condition has improved without damage to the agriculture production because of wise use of land resource by tree farming. This has also helped the marginal and small farmers to come out of the clutches of middle man or money landers as they can harvest the trees when they are in need which is not the case with agriculture crop.

Why Eucalyptus gets preference over other species for farm forestry.

While selecting the species for farm forestry main considerations are as under :

(1) It should be fast growing and have many uses.

(2) It should grow successfully in that particular agro-climatic zone.

(3) It should be possible to take agriculture crop alongwith tree plantation.

(4) As far as possible expenditure on establishment should be minimum and it should regrow by coppices.

(5) It should not be grazed or browsed by the animals.

Considering all those, *Eucalyptus* appears to be ideally suited for farm forestry. As *Eucalyptus* leaves contain aromatic oil, they are not eaten by animals. Hence protection of plantation from stray animals is not a problem. *Eucalyptus* is used as small timber and firewood and also for paper, rayon & pulp manufacturing. It also reduces the salinity in the soil. It grows in 20 cm to 125 cm rainfall zone and in wide variety of soils. It is also an established fact that it is one of the good species for Agro-forestry practices in Gujarat. There is no Indian species which has a similar mechanism.

Also the rate of growth of *Eucalyptus* is much faster than any indigenous species in comparable conditions. However, *Eucalyptus* cannot be used as fodder and does not come up in soils with high pH, value, and poorly drained soil.

There is a lot of controversy about *Eucalyptus* planting. Major charges are (1) Nothing comes up under *Eucalyptus*, (2) It drains more sub-soil water, (3) Impoverishes the soil in which it grows, (4) Does not support wildlife and creates monoculture which is not good for maintenance of eco-system. In this connection, I would like the antagonists of *Eucalyptus* to go through the publication brought out on "*Eucalyptus* Farming—Facts & Fears" by Shri S.K. Sinha, Gujarat Forest Department to remove the wrong notions about *Eucalyptus*. It has been scientifically proved that *Eucalyptus* enriches the soils and intake of water is less compared to biomass production with respect to other common species. It has very good water recharging capacity and water table in the *Eucalyptus* plantation areas have remained the same compared to controlled areas in Gujarat (S.K. Sinha, Gujarat, 1984).

In short, I am of the strong opinion that till some alternative better species are identified for farm forestry, *Eucalyptus* should not be discarded. Economics will take care for the farmers to select the species for farm forestry. In Gujarat many farmers are now switching over to teak, bamboo, shivan planting. In short what Dr. Khoshoo has stated that there is no bad or useless tree or plant unless it is grown in the wrong place, is correct.

Employment generation

There is a criticism that because of tree planting in agriculture land it will

Table 7

Effect of Eucalyptus plantation on underground water tables.

(Results of survey of Gujarat Forest Department, April, '84)

District	Average annual rainfall (mm).	No. of tubewells surveyed in *Eucalyptus* plantations	No. of control wells surveyed outside plantation area in the same village	Results	
				Drop in water table according to farmers	
				Eucalyptus plantation wells	Control wells
Baroda	917	11	8	No drop in level	
Kheda	770	18	8	No drop in level	
Ahmedabad	783	12	10	No drop	Merginal
Sabarkantha	794	37	24	Nil	0.5 m.
Mehsana	613	41	16	1 m.	1.25 m.
Banaskantha	751	24	22	0.40 m.	1.27 m.

reduce the employment opportunities in the rural areas. This is also not correct because tree planting requires care all-round the year, while in agriculture it is mostly seasonal because of scanty irrigation facilities in Gujarat. In addition to this, as mentioned earlier, in Gajarat more tree farming is done on fallow land and along the irrigation channel, where earlier nothing was grown and no employment was generated. From the sample survey of 1920 farmers it has been observed that employment opportunities have increased to the tune of about 1½ times in the same area where tree farming is done. Details are as under :

Table 8

Employment generation (Mandays)

Year	Before tree farming	After tree farming
1977-78	950	988
1978-79	1655	2911
1979-80	8964	13176
1980-81	32270	37679
1981-82	11852	24244
1982-83	27532	57997
1983-84	23513	26278
	107713	163271

There is also criticism that mostly farm forestry has been undertaken by absentee landlord which is also not correct. Details are as under :

Table 9

Details about the farmers adopting farm forestry

(1) Self	1770	92.2%
(2) By others	150	7.0%
Total : 1920		100.0%

This analysis clearly shows that mostly tree farming is done by the farmers themselves and absentee farmers are negligible.

* * *

RESEARCH NOTE

Note on occurrence of white variety of Shemul (*Bombax ceiba* L.) near Karnala Bird Sanctuary, Maharashtra State

Shemul (*Bombax ceiba* L.) is well known tree in India for its magnificent flowers varying in colours from pale red to blood red. The tree in full bloom presents a striking blaze of colour and becomes a bird paradise. In Ayurvedic medicine different parts of Shemul tree are used in treating various human ailments. Especially paste of bark is reputed for curing skin eruptions.

It is often claimed by supporters of traditional use of herbal medicine that white variety of Shemul is more effective in medicine. For last number of years we are making special efforts to locate white variety of *Bombax ceiba* L. during our routine tours to various parts of Western Ghats. But we were not much fortunate. In April 1977, during our plant collection tour to Karnala Bird Sanctuary we came across a solitary Shemul tree with pure white flowers near the village Chinchwan on the way to Shirdhon. Even after much efforts we could not locate any other tree with white flowers.

It is popular belief that white variety of the Lal or Kante Savar has miraculous spiritual powers (human and divine) and for this reason bark of the tree is often stripped off by devotees. This may perhaps lead to the fatal dying of the tree if not checked in time. We have alerted the Forest Department about this rare variety and requested them to undertake multiplication of this rare gene.

It is also said that pure White variety of Dhak or Palas (*Butea monosperma* Lam.) (Taub.) and Pangara or Coral tree (*Erythrina indica* Lam.) are rather rare. Incidently we have seen pure white Pangara at few localities but not yet came across White Dhak or Palas. Readers are requested to kindly communicate the occurrence of such plants on the following address :

Maharashtra Association for the
Cultivation of Science,
Research Institute, Pune (Maharashtra)

V.D. Vartak
and
M.S. Kumbhojkar

LETTERS TO THE EDITOR

(I)

To,

The Honorary Editor,
Indian Forester
P.O. New Forest, Dehra Dun.

Sub : **Utilisation of *Eucalyptus* raised under high density plantations**

Sir,

From the reports received from Gujarat, Punjab, Karnataka and elsewhere, it is seen that some farmers are practicing High Density ***Eucalyptus*** Planting (HDEP) as suggested by Dr. V.J. Patel. In my article published in ***Indian Forester***, 109 (7), it was pointed out that contrary to the expectations, such plantations are not likely to yield high money returns. From the data on growth of 2½ years old plantation on an average type of land, it was seen that major portion (over 75%) of wood comprised of small dimension poles i.e. b.h. o.b. diameter of less than 7.5 cm; trees were thus, not likely to attain marketable size (pole) in a short period. Moreover, the wood harvested would contain large percentage of bark and sap wood and thus though total biomass will be substantial, in conventional market, it will be difficult to sell.

The possibility of utilising material from the HDEP as a source of raw material for paper and pulp has been examined and it is reported that material from such plantations is an ideal source of news print grade mechanical pulp. The pulp made from three years old tree samples had higher bonding strength and that pulping can be done with bark on, without adversely affecting the pulp properties. (High Density Plantations (HDP)—a source of pulp paper making raw material by Tiwari ***et al***, IPPTA Seminar 1983, New Delhi).

As a major portion of wood harvested from such plantations for paper mills will be of small dimension poles, transport of such material by a conventional off road and road transport will be costly proposition. Paper and pulp Industries in Japan, USSR etc. are however, transporting wood chips, 'inter alia' from small dimension woods, over long distances, e.g. 1.4 million m^3 solid wood chip from USA to Japan 1967; it was expected that total import of wood chips, in Japan would rise to 30 million m^3 by 1980. It is claimed that the wood chipping has definite advantages like maximum utilisation of wood, conversion of otherwise unsaleable material into commercially useful commodity thereby making forest cultivation easier and cheaper. Suitable techniques and tools for such a heavy demand of wood chips have been developed. Machinery for chipping has been evolved and a wide range of chippers useful for converting even small size trees are available. Some of these are small enough to be acquired by a farmer co-operatives and small industries. Technology for quick transport of chips by trucks, railways and pipe lines has also been developed. To minimise transport costs, compaction of wood chip is also resorted to. (Wood chips-Production Handling and Transport, FAO, 1976). However, there are certain disadvantages of the system. Highly mechanised system will require substantial inputs and it may reduce job opportunities. Such a technology thus, can be introduced in India only after appropriate modifications to suit local conditions are incorporated therein.

Wood chipping, storage and its transport could possibly be handled effectively in the Corporate or Private Sectors. In Gujarat and other parts of the country where co-operative movement has strong roots, farmers can themselves organise wood chipping, its handling and transport, thereby minimising the transport costs and to optimise net returns. These will generate tremendous raw material potential for paper and pulp industries, which could be established in the region itself, and thus this option merits trial.

Yours faithfully,

Sd/- M.G. Gogate

Assistant Silviculturist (G),
F.R.I. & Colleges,
Dehra Dun

Dated 5-6-1984

(II)

To

The Hony. Editor,
Indian Forester,
P.O. New Forest,
Dehra Dun

Sir,

Wood is in a short-supply and the position of matchwood may be worse. With a view to economise in wood consumption, it is suggested that match sticks be packaged in paper/card board cartons containing one thousand match sticks. With these match sticks should accompany one plastic match box and eighteen spare sticker strips which could be pasted on the box by the end-user when those already provided wear out. Thus the plastic match box of fifty match stick capacity could be used twenty times over again. This may help in saving wood which is being consumed in the manufacture of match-boxes. Beside economy in wood, the match-sticks may reach the end-user at a leasser cost.

Yours faithfully,

Sd./- H.P. Sharma.

Co-ordinater,
Conifers Research Centre,
Shimla.

Dated : 31-5-1984,

OBITUARIES

(I)

Ram Baboo Johri

(1931-1984)

With profound regret we announce the sudden and untimely demise of Shri R.B. Johri, I.F.S (U.P. Cadre). He died at Bareilly on 20.4 1984 after a brief illness. Shri Johri was a first class graduate of the Allahabad University and joined forest service in 1954 after passing A.I.F.C. Diploma with Honours from Indian Forest College, Dehra Dun.

During his service he held a number of very important posts. He was Personal Assistant to the Chief Conservator of Forests, U.P. for over 5 years and served as Secretary, Central Forestry Commission in Govt. of India also for more than five years. During his tenure as Secretary, Central Forestry Commission he took up the revision of the Indian Forest Act 1927 and Indian Forest Policy 1952.

At the time of his death he was Managing Director of the Indian Turpentine & Rosin Company Bareilly. He brought this company from a position of loss to a sizeable profit. His untimely death is a great blow to the forest service and the U.P. Forest Department.

As a person he was of extremely amiable nature, very hardworking, a hard task master but never said a harsh word to any body.

He is survived by his wife and three sons who are well placed.

R.D.G.

(II)

Trilokinath Bhargava

(1935-1984)

It was with profound grief and stunning shock that the news of sudden demise of Shri T.N. Bhargava, I.F.S. was received. He literally died, with his boots on. No one could, believe his ears that a man, who was cheerfully working in his office till late, would be no more by midnight. It was a massive heart attack that claimed him around midnight on 5th – 6th April 1984.

A man of astounding intelligence and impeccable integrity, Shri Bhargava was also one of the most "trained" officers in the state, having had undergone Soil Conservation and Photo-interpretation courses in addition to his A.I.F.C. Diploma course with the 1961 batch.

His last posting was a Divisional Forest Officer, Soil Conservation Division, Raigarh (Madhya Pradesh).

He leaves behind his wife, a son and a daughter.

May God rest his soul in peace.

M.K.M.

GAZETTE NOTIFICATIONS

F.R.I. GAZETTE

Shri Edwin Jeyaraj an officer of Tamil Nadu State Forest Service relinquished charge of the post of Assistant Instructor, Southern Forest Rangers College, Coimbatore (under the Forest Research Institute and Colleges, Dehra Dun) held by him on deputation basis on the 2nd January, 1984 (Forenoon).

The President is pleased to appoint Shri Edwin Jeyaraj, State Forest Service (Tamil Nadu), as Instructor, Southern Forest Rangers College, Coimbatore, in a temporary capacity, on deputation basis w.e.f. 2nd January, 1984 (Forenoon) or until further orders, whichever is earlier.

On selection to the post of Lecturer/Research Officer in the Wildlife Institute of India the services of Shri Shiv Prasad, Research Officer of this Institute are placed at the disposal of Wildlife Institute of India, with effect from 11.1.1984 (Forenoon).

On relinquishing charge of his duties as Research Officer in the Forest Research Institute & Colleges, Dehra Dun on 31.5.84 (AN), Dr. S.S.R. Bennet, an officer of the Research Officers' Grade of G.C.S., Group 'B' is relieved from his present post to enable him to join the post of Asstt. Professor in the Wildlife Institute of India, Dehra Dun, on usual deputation basis.

HARYANA GAZETTE

1. Shri R.L. Juneja. HFS has been posted as Divisional Forest Officer, Monitoring and Evaluation, SFP Panchkula.
2. Shri Satish Kumar, HFS, has been posted as Divisional Forest Officer, Sirsa.
3. Shri S.S. Sikriwal, HFS. Divisional Forest Officer, has been posted as Attached Officer, Working Plan Divn., Ambala.
4. Shri Subh Ram, HFS, has been posted as ACF, Working Plan Divn., Ambala.
5. Shri Ravinder Singh Lamba, HFS, has been posted as ACF, Working Plan Divn., Ambala.
6. Shri Vinod Kumar HFS, has been posted as Attached Officer, ACF, Research & Training, Pinjore.
7. Shri S.L. Kaushik, HFS, has been posted as Attached Officer, ACF, Research & Training, Pinjore.

8. Shri Partap Singh HFS, has been posted as A.O., SFP Divn., Gurgaon.

9. Shri S.D. Bhatia, HFS, has been posted as A.O. South Circle, with Headquarters at Gurgaon.

10. Shri Phool Chand, HFS, has been posted as A.O. Morni Forest Divn., Pinjore.

HIMACHAL PRADESH GAZETTE

The Governor, Himachal Pradesh, is pleased to order the transfers and postings of the Conservator of Forests in the Department of Forest Farming and Conservation in the interest of public service with immediate effect as under :—

Name	From	To
1. Shri G.C. Chaudhry	C.F. Soil, Dharamsala.	C.F. Mandi (Newly opened Circle).
2. Shri B.S. Chauhan	C.F. Working Plan.	C.F. Rampur (Newly opened Circle).
3. Shri P.C. Sharma	C.F. Wild Life & Development.	Director, Marketing, H.P. SFC, Shimla.
4. Shri S.R. Arya	C.F. Soil, Shimla.	C.F. Wild Life and Development, Shimla.
5. Shri B.N. Ghildyal	Director, Marketing, H.P. SFC, Shimla.	C.F. Working Plan, Dharamsala.

* * *

FRI Publications

FOREST RESEARCH INSTITUTE AND COLLEGES, DEHRA DUN

Indian Forest Leaflets

No. 197—*Wood Working.* Economic conversion of logs, by B.S. Rawat and K.L. Arora. (Symbol No. PFRI. 61.197) Price Rs. 5.00 or £ 0.58 or $ 1.80.

Indian Forest Bulletins

No. 272—*Wood Preservation.* Natural resistance of different species of Indian timbers to marine wood-borers in Bombay Waters, by L.N. Santhakumaran and K.H. Alikunhi. (Symbol No. PFRI. 191). Price Rs. 11.50 or £ 1.35 or $ 4.14.

Indian Forest Records

Vol. 1, No. 1—*Forest Influence.* Effect of tree and litter covers on climate near the ground including surface soil temperature and Soil moisture in three forest plantations of Chir (*Pinus roxburghii*) Sal (*Shorea robusta*) and teak (*Tectona grandis*) at New Forest, Dehra Dun, by B.K. Subba Rao and S.K. Pande. (Symbol. No PFRI 186) Price Rs. 15.75 or £ 1 84 or $ 5 67.

Vol. 2. No. 1—*Forest Influence.* Microclimate of Sal coppice forest by R.C. Ghosh, B.K. Subba Rao and B.C. Ramola. (Symbol No 165 11. 1). Rs. 43 50 or £ 5.08 or $ 15.66

Vol. 3, No 1—*Statistical.* Point sampling with a rope – A novel and useful method for forest surveys, by K.R Satyamurthi (Symbol No PFRI. 200) Rs. 3.50 or £ 0 41 or $ 1.26

Other Publications

Troup's Silviculture of Indian Trees, Vol III (Revised 1981). (Symbol No. PFRI. 188) Price Rs 89.00 or £ 10.38 or 32 04.

Proceedings of the Eleventh Silvicultural Conference, Dehra Dun, May 1‘th to May 25th 1967, Vol. III (1-83). (Symbol No PFRI. 161. III) Rs.195 00 or £ 22 80 or $ 70 38.

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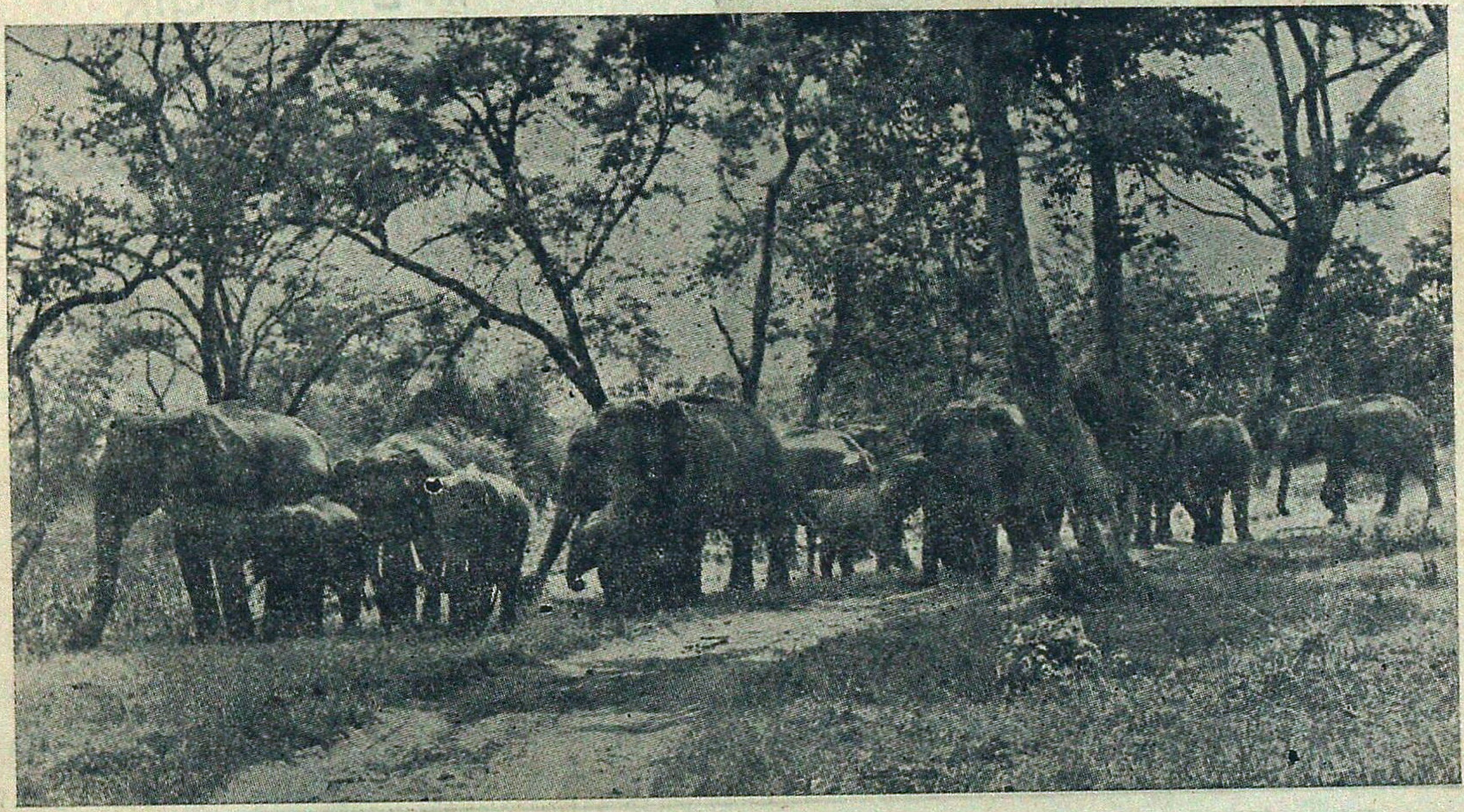

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For further particulars, please contact

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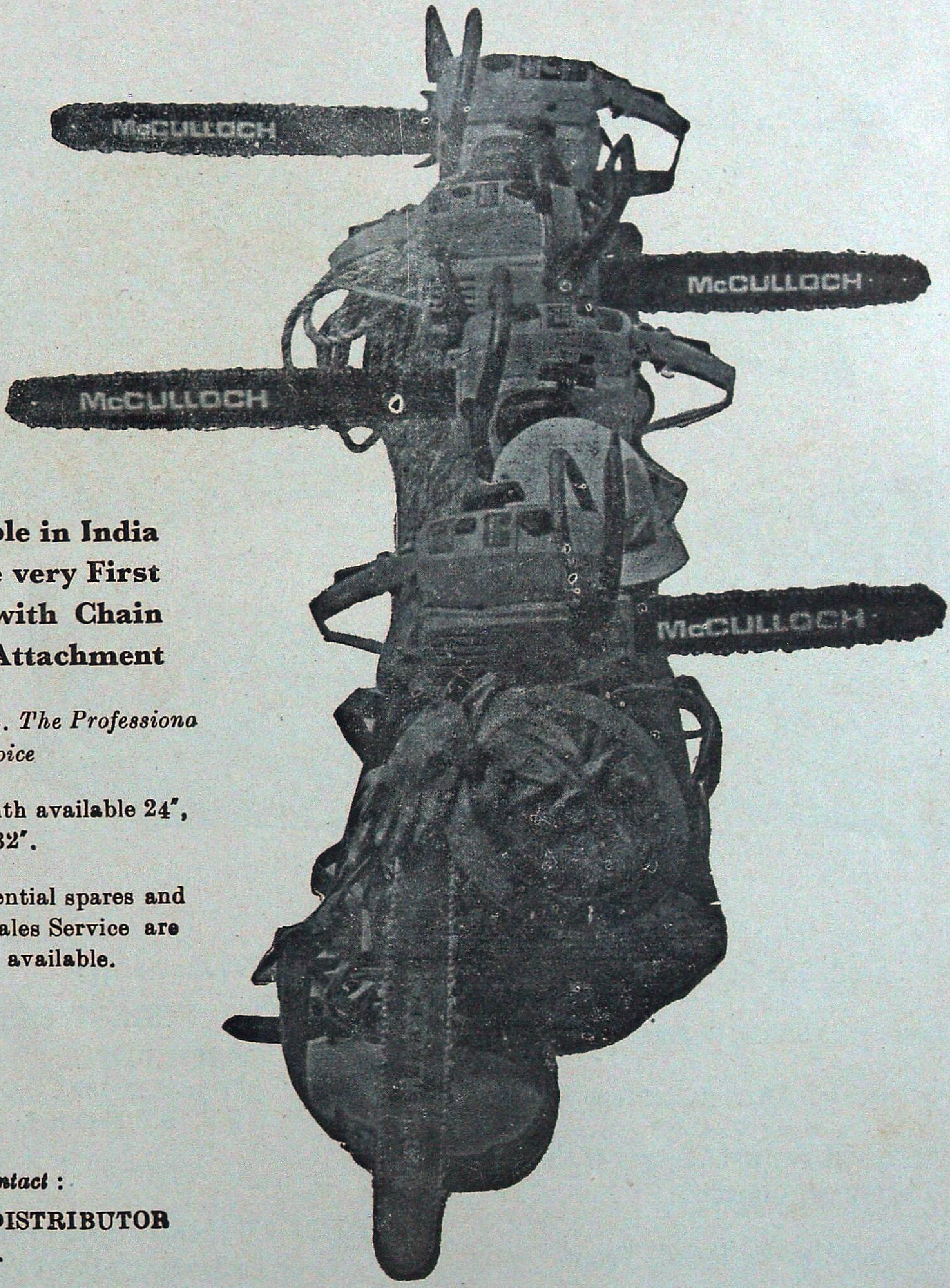

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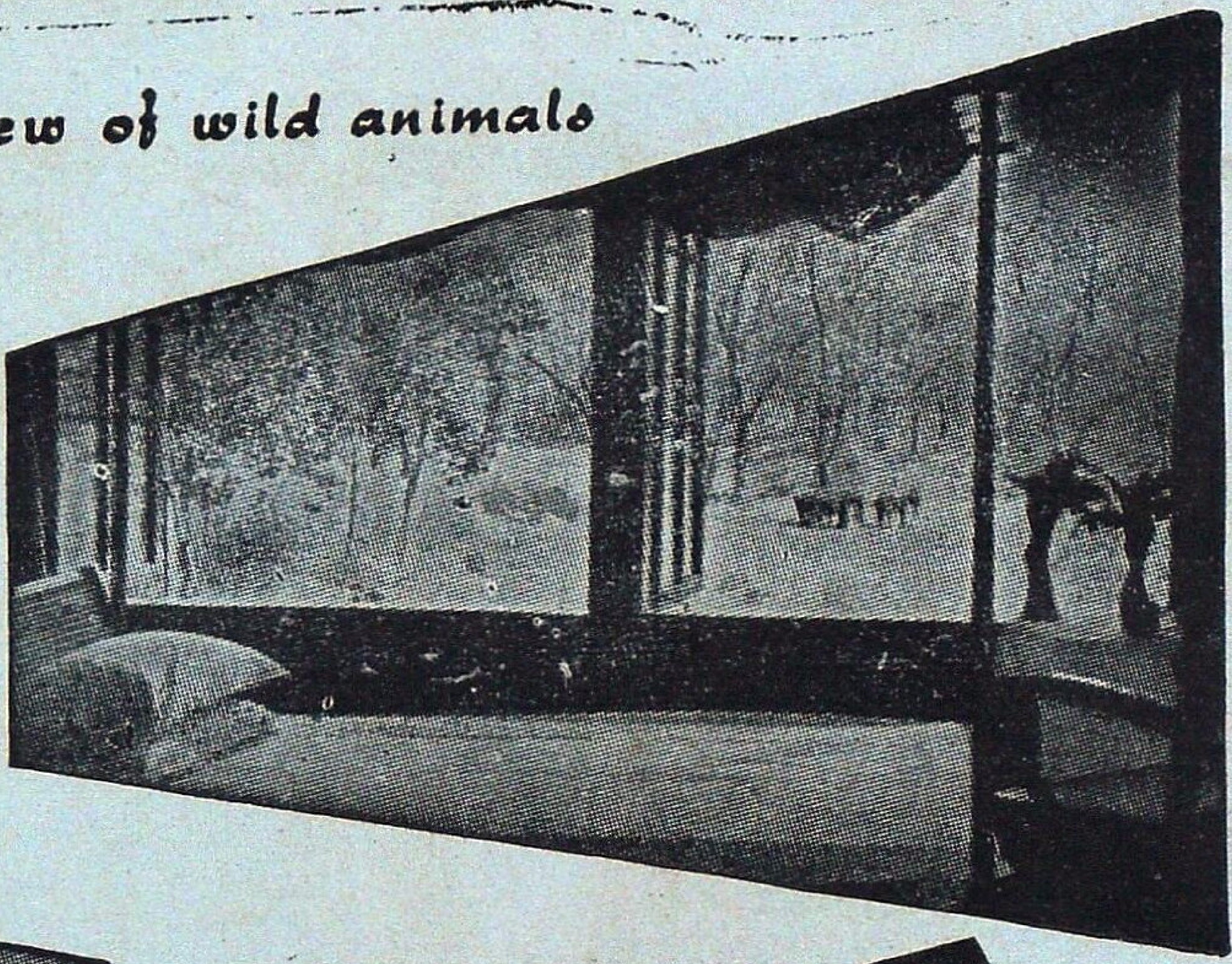

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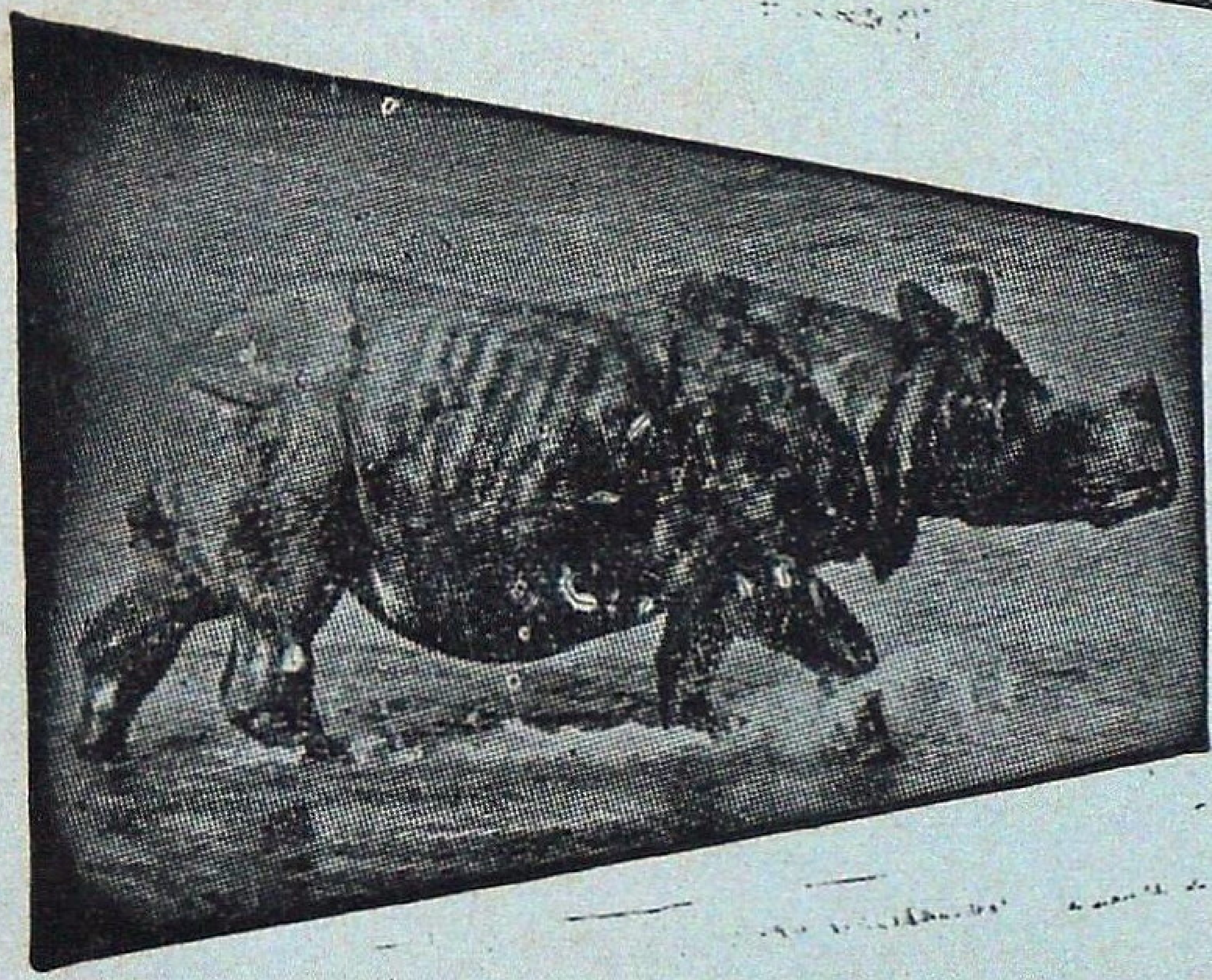

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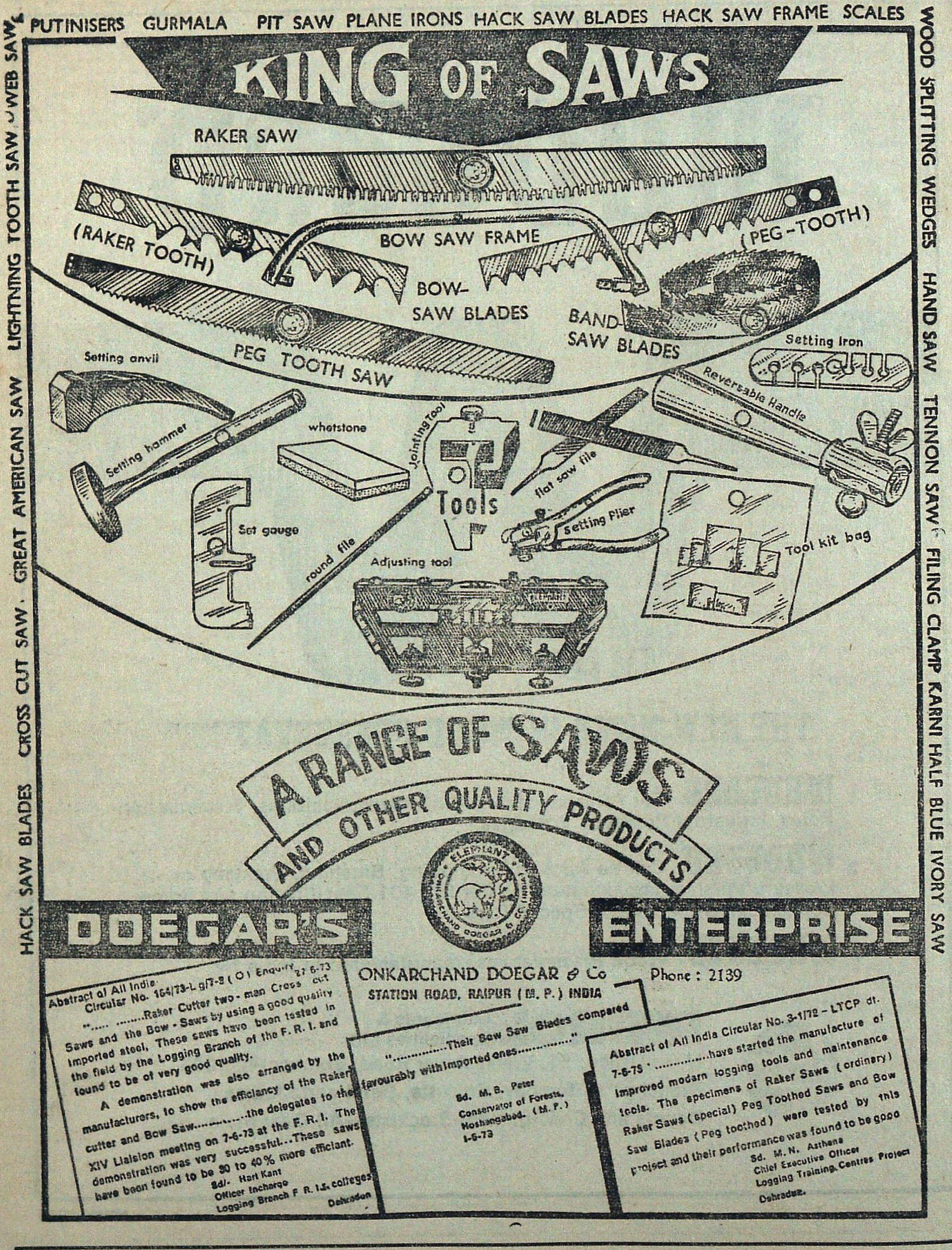
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Sd/- Hari Kant
Officer Incharge
Logging Branch F. R. I. & colleges
Dehradun

"..............Their Bow Saw Blades compared favourably with imported ones................"

Sd. M. B. Peter
Conservator of Forests,
Hoshangabad. (M. P.)
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Abstract of All India Circular No. 3-1/72 – LTCP dt. 7-6-73 '...............have started the manufacture of improved modern logging tools and maintenance tools. The specimens of Raker Saws (ordinary) Raker Saws (special) Peg Toothed Saws and Bow Saw Blades (Peg toothed) were tested by this project and their performance was found to be good

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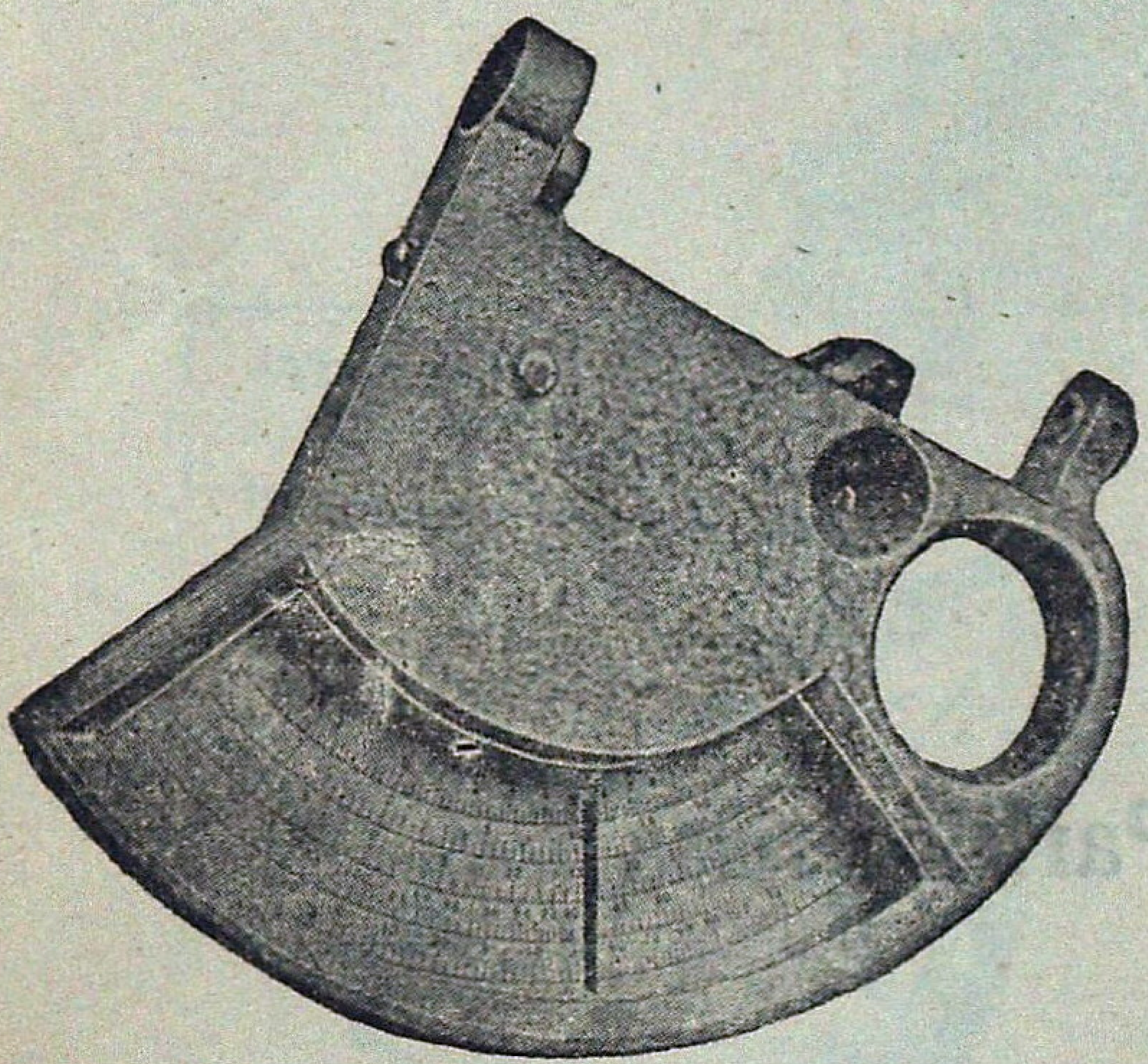

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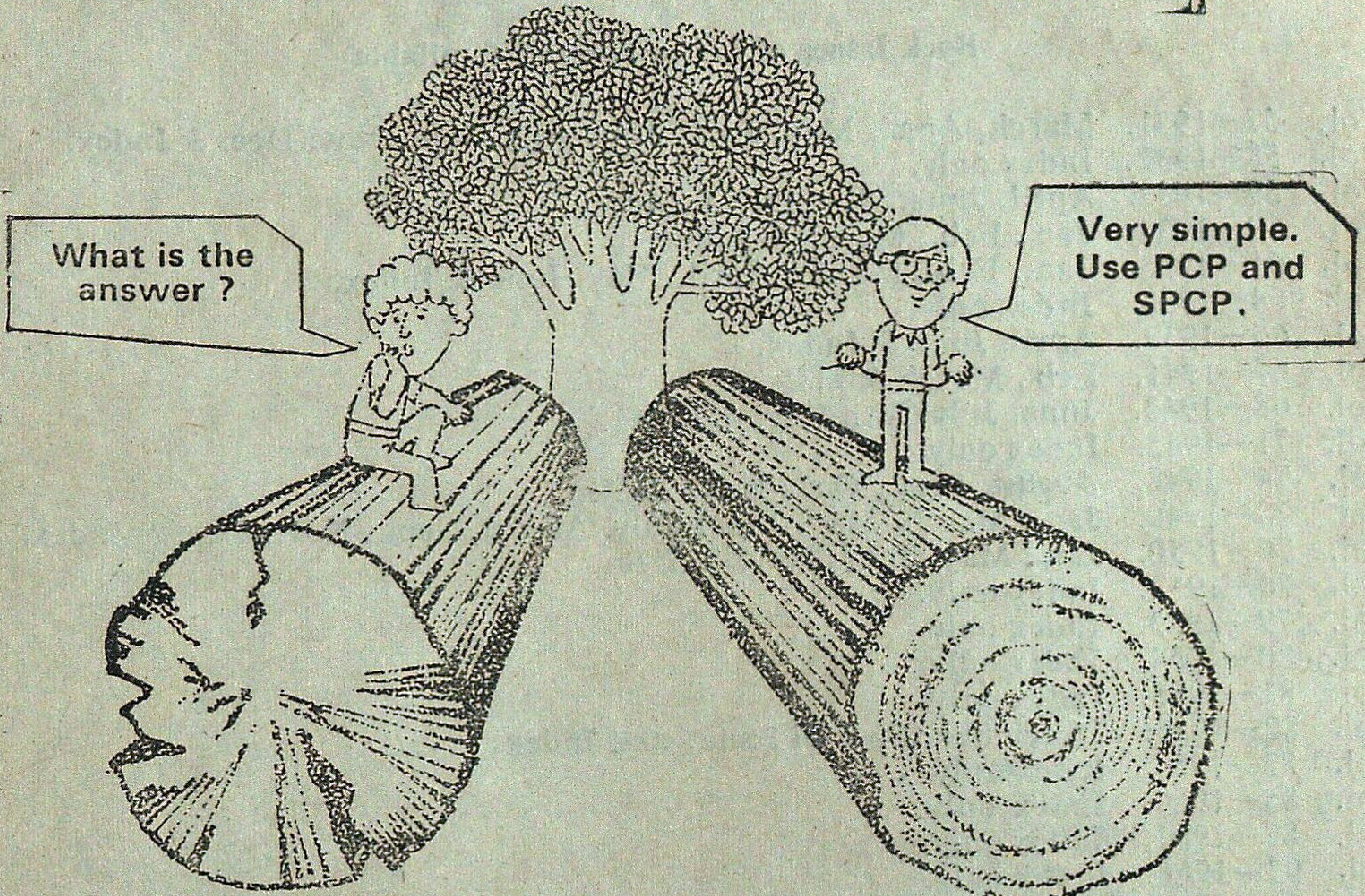
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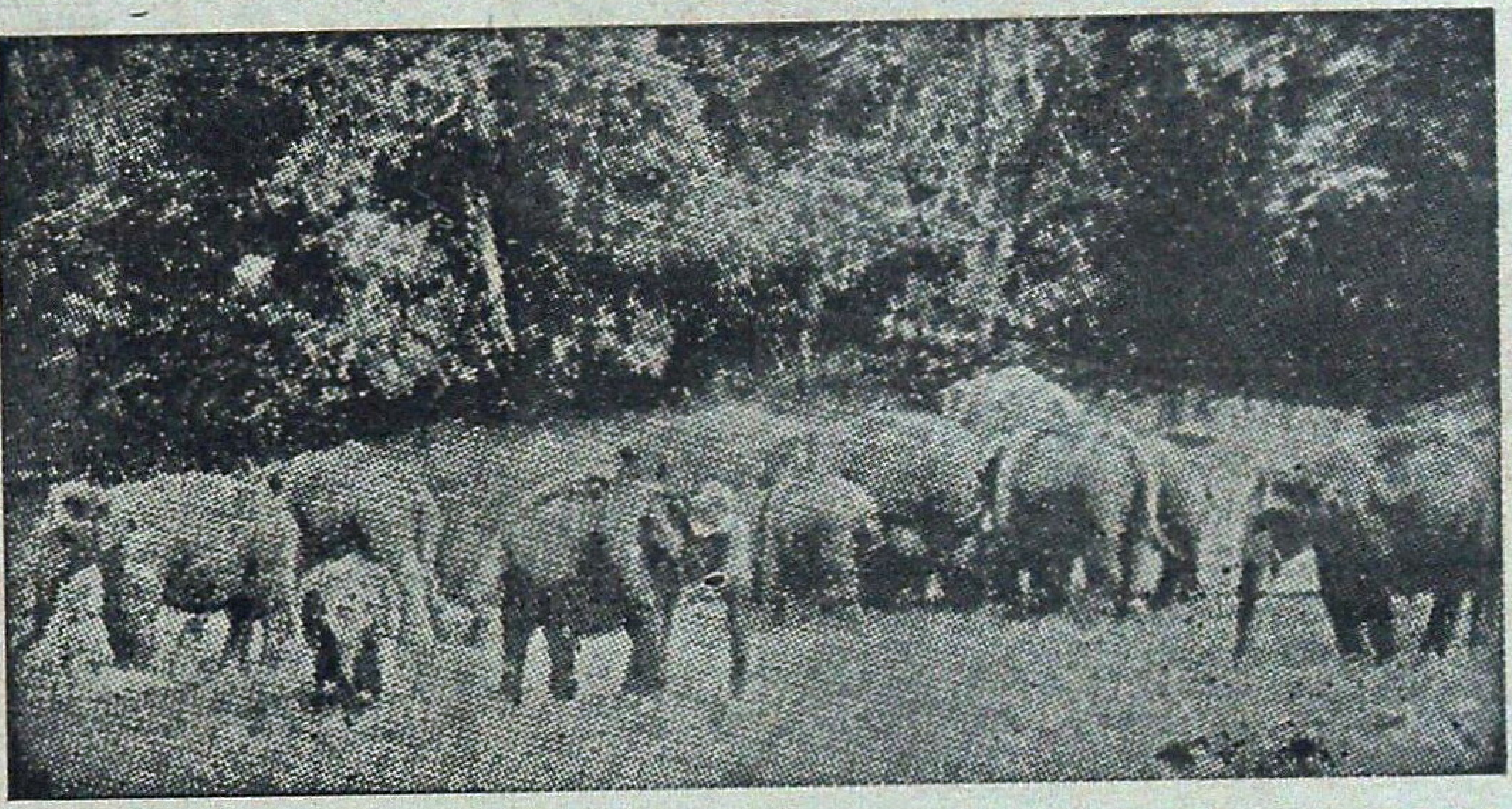

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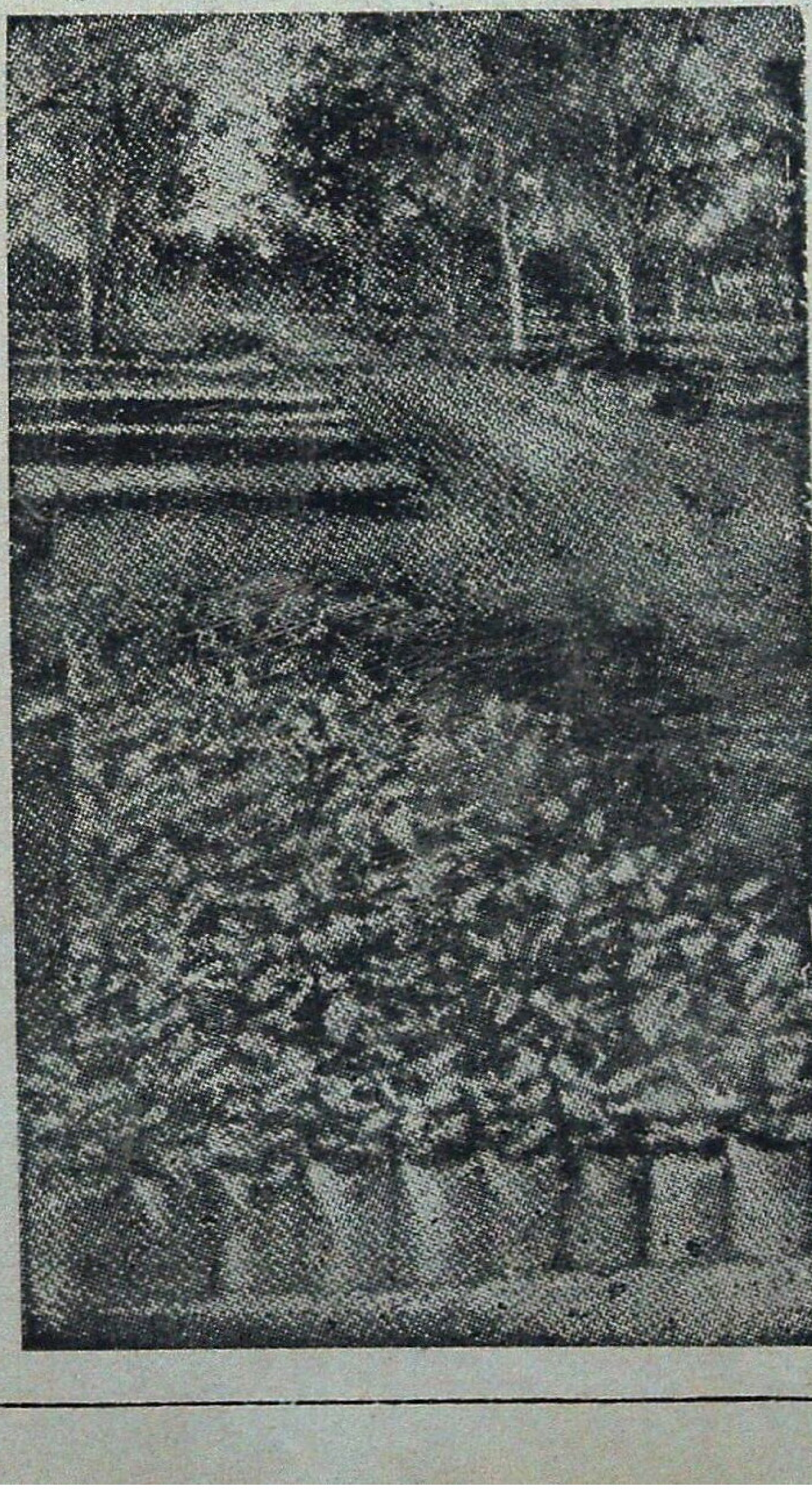

THE
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VOLUME 110 JUNE, 1984 NUMBER 6

TWO RECIPROCAL HYBRIDS (F_1) OF *EUCALYPTUS CITRIODORA* × *E. TORELLIANA* IN THE CENTRE AND PARENTS ON EITHER SIDE AT THE AGE OF 2.5 YEARS.
Photo—Dr. M.L. Kapoor ... Front Cover

CONTENTS

EDITORIAL

ARTICLES

A MODIFIED NELDER DESIGN TO ACHIEVE SQUARE OR TRIANGULAR SPACING. K.P. Rustagi 521
SEED DISPERSAL, SEED GERMINATION AND SEEDLING ESTABLISHMENT IN NATURAL FORESTS OF SILVER FIR AND SPRUCE I. SEED DISPERSAL PATTERN. Virendra Singh and R.V. Singh 529
AN ECO-BIOMETRICAL STUDY ON TIGER IN THE ESTUARINE ECO-SYSTEM OF SUNDARBANS. Kalyan Chakrabarti... ... 540
AN OBSERVATION ON THE INCIDENCE OF CHARCOAL ROOT-ROT DISEASE OF *PINUS CARIBAEA* PLANTATIONS OF BASTAR (M.P.). Jamaluddin, V.S. Dadwal and K.K. Soni 552
A NEW DEFOLIATOR OF *CEIBA PENTANDRA* (L.) GAERTN. FROM TAMIL NADU, INDIA. M.L. Thakur and S.R. Madhavan Pillai ... 558
CONSTRUCTION OF VOLUME TABLES—A GENERALISED APPROACH. K.P. Unnikrishnan and Ravendra Singh 561
STUDIES ON THE RELATIONSHIP OF CINEOLE CONTENT OF THE OIL AND STOMATA CHARACTERS OF *EUCALYPTUS* HYBRID (*E. TERETICORNIS*) LEAF. S.S. Bisen, V.V. Prabhu and K.S. Theagarajan 577
A NOTE ON PRODUCTION OF HIGH ALPHA CELLULOSE PULP FROM *LEUCAENA LEUCOCEPHALA* Y.K. Sharma, Sushma Mahajan and P.P. Bhola 582
CROP VOLUME AND OUT-TURN TABLE FOR STANDS OF *ACACIA NILOTICA*. H. Rajagopal Shetty 586
GUJARAT EXPERIENCE OF *EUCALYPTUS*. G.A. Patel 591
RESEARCH NOTE 599
LETTERS TO THE EDITOR 600
OBITUARIES ... ... Art Paper
GAZETTE NOTIFICATION xi

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